Workshop on Advanced Learning Technologies for Disabled and Non-Disabled People (WALTD)

ICALT 2008: The 8th IEEE International Conference on Advanced Learning Technologies :
Learning technologies in the Information society
Santander, Cantabria, Spain, July 1st- July 5th, 2008
http://www.ask4research.info/icalt/2008/

Sponsored by:

Supported by:

Ayuntamiento de Santander

Master in management and production of e-learning

Organized by

Laboratorio DEI, Universidad Carlos III de Madrid

Workshop chairs:

Dr James Ohene-Djan - mas01jo@gold.ac.uk
Goldsmiths College, University of London,
New Cross, London, SE14 6NW
Tel: + 44 207 919 7862
j.djan@gold.ac.uk

Dr Marion Hersh - m.hersh@elec.gla.ac.uk
Department of Electronics and Electrical Engineering,
University of Glasgow
Telephone: 0141-330 4906
m.hersh@elec.gla.ac.uk

Workshop on Advanced Learning Technologies for Disabled and Non-Disabled People (WALTD)

ICALT 2008: The 8th IEEE International Conference on Advanced Learning Technologies : Learning technologies in the Information society
Santander, Cantabria, Spain, July 1st- July 5th, 2008
http://www.ask4research.info/icalt/2008/

Workshop chairs:

Dr Marion Hersh - m.hersh@elec.gla.ac.uk
Dr James Ohene-Djan - mas01jo@gold.ac.uk

Workshop Description:

Education should be considered a basic right. It is also vital for personal and social development, to give individuals opportunities and society a future. It should also be considered a right of every person to contribute to society to the maximum of their ability. Access to education, particularly further and higher education, increases the contribution people can make. However, many disabled people currently experience numerous barriers in accessing both education and employment and are in an enforced state of dependence, rather than being able to earn their own livings and contribute to society. It is therefore important to examine the barriers to increased participation by disabled people in education in order to determine ways to overcome them.

The focus of this workshop will be learning technologies and the associated underlying pedagogies. Computer based and multi-media learning technologies have become particularly important, but there are also very important lower level technologies such as textbooks and multi-purpose technologies such as laboratory equipment. Disabled people may require access to assistive technology, such as a screenreader, voice input software or an onscreen keyboard in addition to learning technology in order to obtain the full benefit from education. Although disabled people often experience serious barriers in accessing and getting the greatest benefits from education, there have been advances and there are examples of good practice.

In addition, questions arise concerning the accessibility and usability of learning technologies to disabled and non-disabled users. Accessibility is concerned with the environmental characteristics of the system input and output which either enable or prevent particular groups of users from using the system, whereas usability is the ability of the system to carry out the intended function(s) when used by particular groups of users. Other important issues relate to the cultural appropriateness of the learning content and the availability of learning technologies and the associated documentation in different languages. Related issues include the choice of icons, symbols or abbreviations to denote particular activities or carry out operations. There are also specific cultural and other issues relating to the provision of learning technologies, preferably in the appropriate national sign language for Deaf people.

Three main questions are addressed by the workshop were

1. What is the current state of the art regarding the development of Advanced Learning Technologies for Disabled and Non-Disabled People?

2. How are specific challenges related to accessibility and usability of content and presentation in advanced learning technologies currently being addressed

3. Should a design for all approach or design for specific groups of learners approach be taken in the future?

4. What are the key pedagogical and cultural issues in relation to designing and implementing learning technologies for disabled and non-disabled students?

Paper Submission:

Authors are were invited to submit papers of up to 5 pages describing research related to WALTD for publication in the workshop proceedings edited by the workshop chairs. Authors could also submit two-page papers for review for inclusion in the IEEE conference proceedings of ICALT2008.

Work Participants:
The workshop is not exclusive to, but is meant especially for the following categories of participants:

• Developers, students and educators interested in addressing accessibility and usability issues in the design of advanced learning technologies.

• Researchers who want to explore the pedagogical and cultural issues associated with addressing the needs of disabled and non-disabled students using learning technologies.

• Students and educators with minimal technical background interested in researching learning technologies as a key factor in giving disabled people opportunities for both personal development and economic independence

Workshop Organization:

The workshop will lasted for 2 and ½ hours.
The workshop consisted of 3 sessions each based on one of the 3 main questions addressed by the workshop.
Each session consisted of 10 minute paper presentations followed by a 10 minute interactive discussion.

Contact Details:

Please direct any questions on WALTD to
Dr James Ohene-Djan
Lecturer
Department of Computing
Goldsmiths College
University of London
New Cross London
SE14 6NW
Email: j.djan@gold.ac.uk
Tel: 020-7919-7862
Fax: 020-7919-7853

Table of Contents

An Intelligent Engine for the Generation of Adaptive Tutorials

Tomás Álvarez, Carmen Escribano, Daniel Fernández,
Antonio Giraldo and María Asunción Sastre
Computer Science School, Technical University of Madrid
zombie.esetipo@gmail.com, cescribano@fi.upm.es, danielfernandezpurroy@gmail.com, agiraldo@fi.upm.es, masastre@fi.upm.es

Abstract

The goal of this work is the design and construction of adaptive tutorials based on the application of algorithms for the automatic resolution of problems which can be used to automatically generate texts of a formative character, practical exercises or tests and to evaluate them.

1. Introduction

The use of technology in teaching is a very active field of research. In the last years there have appear a great number of proposals to introduce innovative tools in teaching, especially in connection with the World Wide Web. In particular, the subfield of adaptive tests is also being explored [1, 2, 3] and is expanding in connection with the semantic web [6].

This evolution towards the use of (intelligent) e-learning tools is particularly appropriate and useful for disabled users with limited movability. Due to the generic and modular nature of our inferential engine (see figure 3) the formative strategies could be adapted to the special requirements of a wider spectrum of disabilities.

In this work we describe a supporting tool for the teaching of mathematics courses. The general plan is divided in several parts which converge in the design and development of an intelligent engine for the generation of adaptive tutorials. Moreover, the work here described could be used in other areas different from mathematics. The modules in which this work can be split are:

- Automatic generation of texts.
- Automatic generation of exercises.
- Automatic evaluation of exercises.

These modules are based on a knowledge base specifically designed to store the information related to the knowledge to be created.

In the next sections we explain in some detail how to design and construct these different modules.

2. Ontologies

The knowledge system of the inference engine is based on ontologies, having arrived to this conclusion after studying the fundamentals of the Semantic Web, area with a wide literature. Initially, the RDF (Resource Description Framework) language was not appropriate for the intended work. However, the services supplied by OWL (Ontology Web Language, a language to describe ontologies) provide the base of appreciation of knowledge described in a computational language.

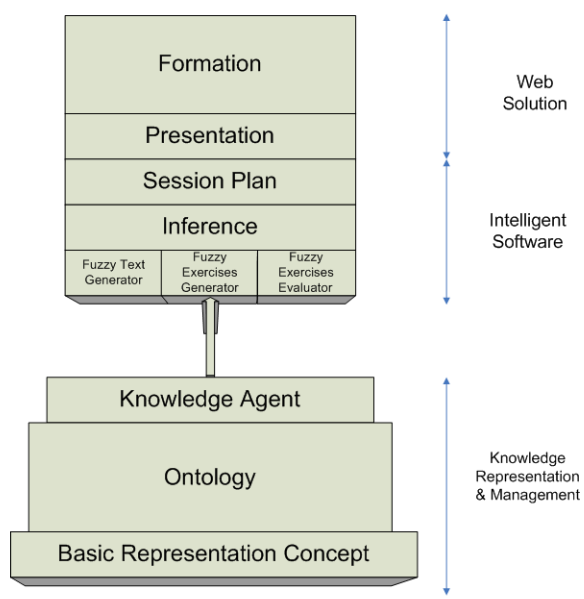


Fig 1. Basic Architecture Scheme

The ontology would contain the information about the subject to learn, related by concepts and chunks, and marked with meta-information essential for the search agents to select the appropriate information. In the future, an intelligent agent should be able to provide a way to search these structures to extract fragments of information and take them to a higher level of processing, in such a way that the user receives the appropriate theoretical information in relation to his current knowledge.

Therefore, the objectives on the long run would be to obtain a clear and concise ontology generic model that could be used by an agent to make consultations and searches. Moreover, other objectives would be to construct examples for those ontologies in relatively small and manageable fields. The growth of the ontology should be scaled, i.e., the different ontological nets form themselves an ontology.

3. Automatic generation of texts

Several Artificial Intelligence techniques and technologies, in particular those related with the automatic resolution of problems [4], can be used for this task. The main components of this module are:

- Fuzzy control of the speed of the learning plan: The input for the system would be the answers of the student which, properly interpreted in a score/difficulty table would be understood as statistics about the student knowledge on a particular subject. Using this data, the controller would give as a result a calibration of the learning plan the student should follow, as well as a vector of indications to elaborate the work plan (this would be also useful to generate adequate exercises). The better the answers, the faster the plan will be.
- Texts planner: The input for this module would be the advance made by the student on the syllabus and the calibration vector above mentioned. This module would be a hierarchic planner which would look at a knowledge base on the area in order to select appropriate texts, diagrams and tutorials according to the calibration vector. The knowledge base would be based on ontologies (using the technology XML). The output of this tool would be a file about the progress in the syllabus which could be used as input for the same planner in future sessions. Moreover, the use of standard web technologies implies that this tool could interact with other teaching tools.

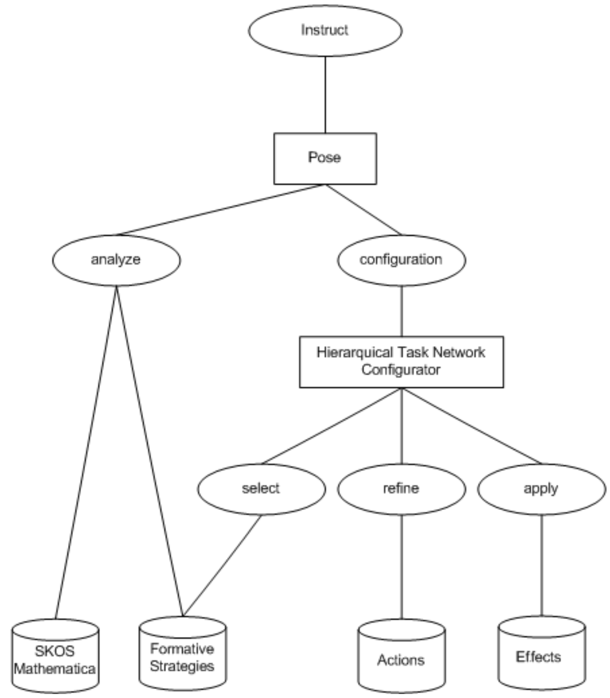


Fig 2. Automatic Generator of Text Solution

The result of this module is a planning for the publication of texts indexed by the ontology described in section 2. This planning would serve as a guide to generate the associated dynamical web.

4. Automatic generation of exercises

The main components of this module are:

- Fuzzy controller of difficulty: The results of the above described fuzzy controller would be used to establish a criterion suitable for the generation of the exercises according to its type, difficulty and usefulness.
- Planner of exercises: For the generation of exercises, a propose-review model is proposed. First, the type of exercise to construct would be chosen (in principle, a Simple Knowledge Organization System - SKOS – is proposed to store the knowledge about the types of exercises) and, later, it would be parameterized. In case that a parameter were not coherent with the problem or with the other parameters, a change would be proposed on it, and the exercise would be revised again.

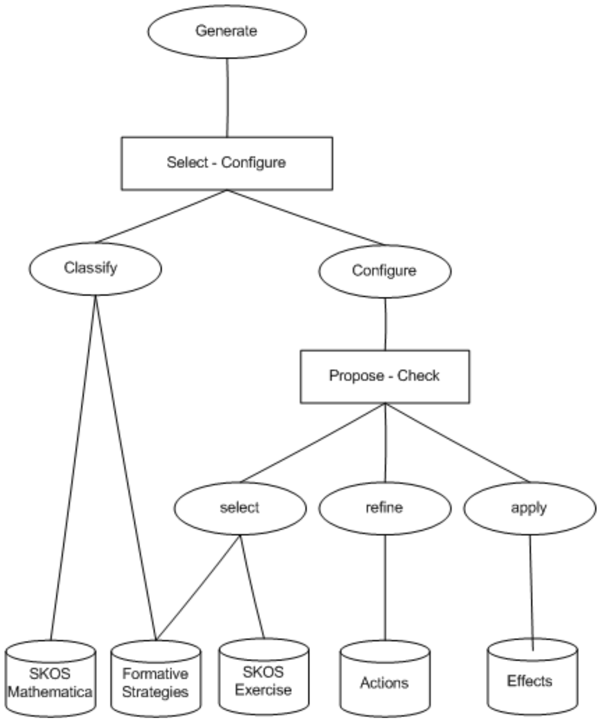


Fig 3. Automatic Exercises Generator Solution

The output of this module is a planning of exercises, complementary to the planning of theory. The exercises model will have its own knowledge base, which would contain the different types of exercises and their functions.

5. Automatic evaluator of exercises

A possible solution to this problem is also proposed. The main components of this module are:

- Planner of exercises: The configuration of the exercise would be detected, as well as a tree of different ways to solve it. The problem would adjust itself according to the answers provided by the student.
- Generation of solutions: Taking advantage of the great amount of mathematical tools available nowadays, a solution (theoretical, as well as practical) could be programmed for the current exercise in order to have a result to which compare the solution obtained by the student. Maple, Matlab and other platforms could be especially useful in this part of the work.
- Evaluator: The generated solution would be compared with the plan of solution obtained by the student. The tool would verify if it agrees with the right answer and the coherence of the proposed solution would be analyzed. Again, the use of web technologies and languages as MathML [5] would be an advantage.

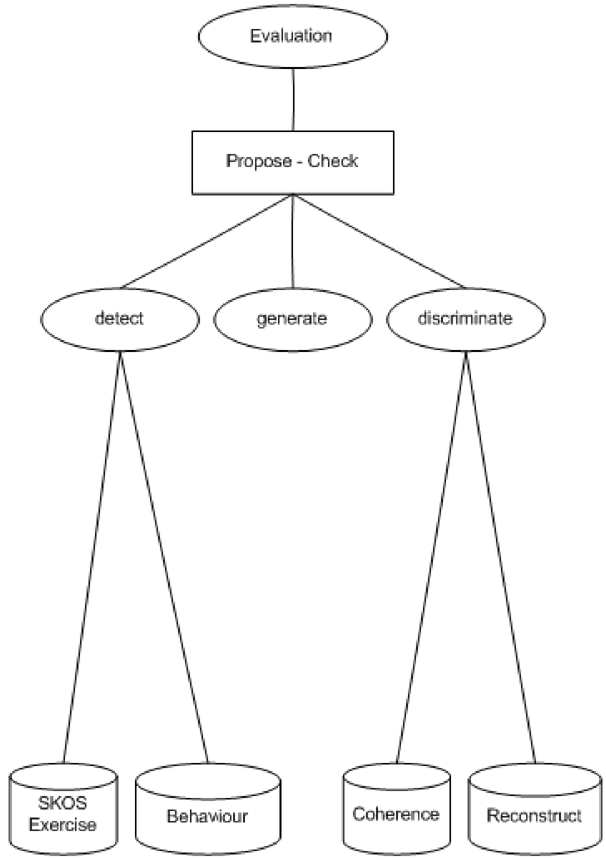


Fig 4. Automatic Evaluator of Exercises Solution

6. Web technologies

Once obtained the execution plan of a tutorial session based on previous results, we have to take a special care in the way the content is presented via web. The use of verbal-iconic systems which take advantage of the multimedia capability of the World Wide Web is essential for the transmission of knowledge. Plug-ins, multimedia files, animations, videos, sounds and other correctly used web-compatible multimedia material will constitute a formation and communication channel plenty of possibilities.

From the point of view of the academic formation (an environment in which we will propose a first approximation of the complete tool) we understand that the complexity of the channel for the communication of the information is itself a problem.

The objective of this paper is not the development of a basic theory on the use of new technologies in education. In fact, there is a lot of information in this area and many research works with concrete and accessible results. However, this topic can not be neglected. Our goal is the development of a technology that could be used independently of the type of education, i.e. we intend to develop the foundations of a more complete tool made in collaboration between professionals of education and of new communication technologies.

7. A framework for the system

One of the advantages of the system that we are developing is its versatility. The same scheme can be used in different fields. On the one hand, it can be modified to be used by people with different disabilities, just changing the strategies module in figure 3. On the other hand, it can be used as a complementary education system in more specialized environments, for example in higher education or in specific enterprise courses.

The implementation of the system will be at the University level, initially for an Infinitesimal Calculus course.

In this framework, the ontologies knowledge would be a network of nodes of knowledge concerning mathematical concepts (not from a mathematical but from a formative point of view) interrelated and tagged according to their complexity, their relevance, etc.

The formative strategies are oriented to higher education and will require as a pre-requisite certain academic level.

The objective is to develop tests for the students in order to establish a median line from which to start instructing the students. In this way the system has some results to reduce the uncertainness upon the user level.

The main objective that we want to acquire, when using this system in education, is to increase the teacher-student communication, not to replace the still necessary classroom sessions with the teacher. However, the student can use the system to self control his progress, while the teacher can monitor the level of the class. In this way, the continuous evaluation pretended in the framework of the European Convergence becomes more tangible.

8. Acknowledgements

This work was partially supported by educational innovation research grant number IE071010043 of the Technical University of Madrid.

9. References

[1] C. Boboila, M.S. Boboila, "Online Evaluation with Trainee-Adaptive Tests", *Proceedings of the 4th WSEAS/IASME International Conference on Engineering Education, Agios Nikolaos, Crete Island,* Greece, July 24-26, 2007.

[2] P. Brusilovsky, J. Knapp, J. Gamper, "Supporting teachers as content authors in intelligent educational systems", *International Journal of Knowledge and Learning* 2 (3/4) (2006) 191-215.

[3] G.-F. Ju, A. Bork, "The implementation of an adaptive test on the computer", *ICALT 2005. Fifth IEEE International Conference on Advanced Learning Technologies,* July 5-8 (2005) Pages: 822 – 823.

[4] M. Molina, *Métodos de Resolución de Problemas: Aplicación al Diseño de Sistemas Inteligentes*, Fundación General Universidad Politécnica de Madrid, Madrid, 2005.

[5] *W3C Math Home*, http://www.w3.org/Math/

[6] *W3C's Semantic Web Interest Group (SWIG)*, http://www.w3.org/2001/sw/interest/

NOESIS: An Enhanced Educational Environment for Kids with Autism Spectrum Disorders

Jason Vittorias, Panagiotis Petrantonakis, Dimitris Bolis, Alexandra Tsiligkyri, Vasiliki Kosmidou, and Leontios J. Hadjileontiadis
Dept. of Electrical & Computer Eng., Aristotle Univ. of Thessaloniki, GR 54124 Thessaloniki Greece
leontios@auth.gr

Abstract

A novel educational environment for kids with autistic spectrum disorders (ASDs), namely NOESIS, is presented in this paper. NOESIS takes into account ASD kids' individual characteristics (level of autism, source sensitivity, reaction target, etc), their emotional state (stress level, hyper-/hypo-tension) during their educational procedure, and creativity during guided- and self-activity (e.g., gaming). It adapts to each kid's specific characteristics through system adaptation and self-regulation procedures. Moreover, it provides assistance to the educator for preparation, customization and optimization of the educational material for each kid and provision of enhanced evaluation procedures (scores/tools) via well-managed Web Services. Parents' updating is also provided via reporting material with learning curve descriptions. Overall, NOESIS contributes to the provision of opportunities to all ASD children to be educated by facilitating access and tuning innovative technology to social needs.

1. Introduction

Not until the middle of the 20th century was there a name for a disorder that now appears to affect an estimated 3.4 every 1,000 children ages 3-10, a disorder that causes disruption in families and unfulfilled lives for many children. In 1943 Dr. Leo Kanner of the Johns Hopkins Hospital studied a group of 11 children and introduced the label *early infantile autism*. At the same time a German scientist, Dr. Hans Asperger, described a milder form of the disorder that became known as *Asperger syndrome*. These two disorders were described as the most frequent pervasive developmental disorders[1], more often referred to today as autism spectrum disorders (ASD). All these disorders are characterized by varying degrees of impairment in communication skills, social interactions, and restricted, repetitive and stereotyped patterns of behavior. From a statistical viewpoint, 1 in 150 children (1 in 94 boys) is born with autism, while about 1.5 million Americans have an ASD. Moreover, autism is the fastest-growing developmental disability, with 10% to 17% annual growth (one autistic child is born every 20 minutes)[2]. At a financial level, $90 billion is the USA annual cost for treatment of autism. Nevertheless, cost of life-long care can be reduced by 2/3 with early diagnosis and intervention. As the central feature of autism is attention-tunnelling, monotropism, computers can be an ideal environment for promoting communication, sociabilility, creativity, and playfulness for individuals even at the extreme of the autistic spectrum. Following the UNESCO principles under the global "Education for All" movement[3] (www.unesco.org/education), the proposed project, namely NOESIS, aims at normalizing the education procedure of kids with autism spectrum disorders by creating a novel educational tool that takes into account their individual characteristics and adapts the educational procedure accordingly.

2. NOESIS structure

NOESIS consists of separate modules that are integrated on a common basis, i.e., to involve kids, educators and parents in an efficient educational environment (see Fig. 1). By implementing the applied behavior analysis (ABA), the most effective education methodology of autistic children [1], enhanced with the latest perspec-

[1] *Rett syndrome* and *Childhood Disintegrative Disorder* are other, quite rare, pervasive developmental disorders.

[2] Growth comparisons during the 1990s: US population increase 13%; Disabilities increase: 16%; Autism increase: 172%.
[3] UNESCO leads the global *Education for All* movement, aiming to meet the learning needs of *all* children, youth and adults by 2015.

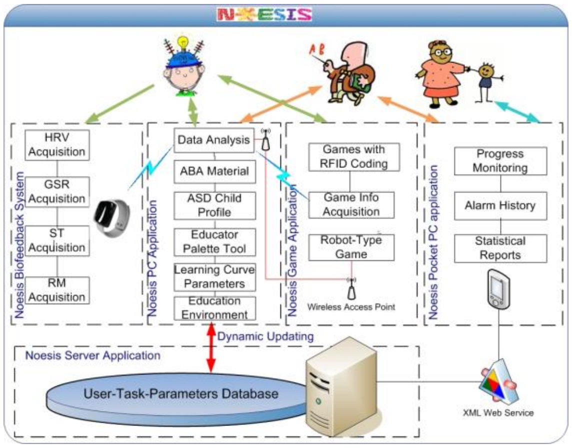


Figure 1. Organizational block-diagram of NOESIS.

tives in autism causes, i.e., embedding educational procedures that aim at mirror neurons (MN) [2] activation, a computer-based tool is designed to assist educators and ASD kids during their education intervention. Non-invasive biofeedback information (such as Heart Rate Variability-HRV and Galvanic Skin Response-GSR, Acceleration-ACC and Skin Temperature-ST) is used to monitor kid's stress during the educational sessions, combined with complexity analysis resulting in adjustable task difficulty, stimuli and help that fit each kid's specific reaction to the current emotional state and task (see Fig. 2).

Transparent monitoring of kid's playing at his/her 'private area', by using Radio-Frequency Identification (RFID) tags-receivers (see Fig. 3) embedded within his/her game parts (e.g., balls, tubes, etc), along with robot-based activities provide additional information about the effects of gaming to his/her educational and social elevation. Moreover, fuzzy logic-based modeling [3] is used across the NOESIS structure to model the whole educational activity, providing real-time scoring information to the educator. With NOESIS, the teacher can select from a variety of 10.000 ABA materials the most appropriate to his/her individual pupil and perform cognitive and meta-cognitive procedures, with regard to the degree of success during the educational intervention (see Fig. 4).

Statistical analysis, comparisons and reports are also outputted from NOESIS, providing valuable information, both to the educator and the parents regarding their kid's progress. NOESIS provides the bed-set not only for exploration of team's abilities to think about and re-design ASD kid's educational approach, but also to understand and integrate the needs of the whole ASD community, in a joint attempt to facilitate their education and contribute to a better quality of life.

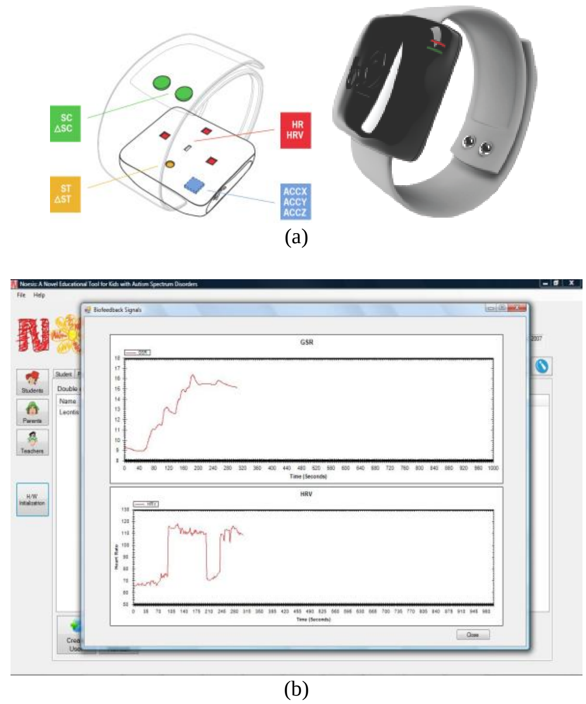


Figure 2. Monitoring of the biofeedback information of the pupil. (a) The Exmocare BT2 Watch (www.exmocare.com), (b)The monitoring screen of the main biofeedback signals (GSR-top, HRV-bottom).

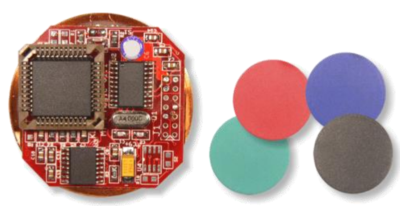


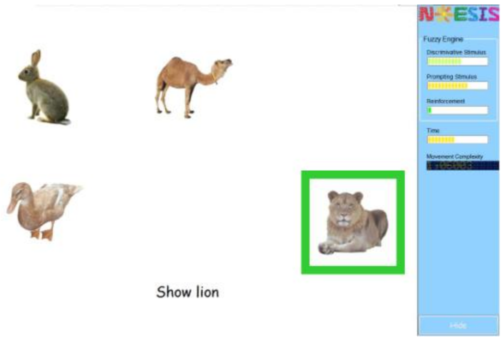
Figure 3. The Mini Magic-232 RFID reader (45 x 45 x 12 mm) and the EM4102 RFID tags (3.0

3. NOESIS user's scenarios

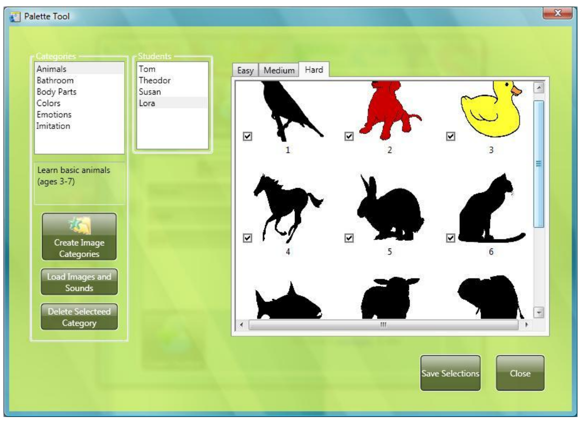
NOESIS aims at the development of a novel educational tool that will facilitate the learning process of ASD kids and contribute to their sociability, according to a series of scenarios. Let's meet Jim, who will guide us throughout the user scenarios.

3.1. Scenario #1: Setting up NOESIS

Jim is an educator for kids with ASD for 7 years at a special school in Thessaloniki, Greece. His experience



(a)



(b)

Figure 4. (a) The ABA-based previewing of the task “Learning the animals”, (b) the educator palette tool.

reveals that autistic kids react positively to computer tasks. Lately, he has heard about a new educational tool, namely NOESIS and decides to test its effectiveness. Starting with NOESIS, he chooses which server he prefers to connect to and follows the system instructions for setting up a new account. Adding the pupils that will be attached to his account, he is requested to fill all the parameters that fully describe the autism level and the cognitive age of each individual kid. In this way the system will point out to Jim which tasks best fit to the pupils' needs. Completing the setup the server updates the database with Jim's account. Jim is willing to check it out with one of his pupils, Theodor.

3.2 Scenario #2: Learning the animals

Theodor is a 3 years old boy, who loves the animals, so Jim asks him to play with the "*Learning the animals*" task. NOESIS adapts the difficulty of the task, the kind and frequency of help and reinforcement according to Theodor's autism parameters that have been setup by Jim. Jim helps Theodor wear the Exmocare BT2 wrist-

Figure 5. The kid plays the game 'Tubes and Balls' and NOESIS recognizes the color of the ball he is throwing into the tube using RFID coding. A complexity analysis is carried to identify pattern-locking and comprehension of the colors.

watch to enable the biofeedback with the application. The task begins, and a set of animal pictures appears on the screen. Theodor is asked with audio and text commands to show a specific animal through a set of animals. Using the special joystick Theodor replies to questions with great enthusiasm for his new "*game"* and get a variety of rewards (visual, auditory) from the computer for his learning efforts. After a while, the questions appear to be difficult for Theodor, making him anxious and unwilling to proceed. His anxiety is obvious not only through his difficulty in answering the questions but through the biofeedback monitoring signals, i.e., a sudden raise of the GSR, HRV, ACC and ST parameters, as well. NOESIS sets an alarm to notify Jim, so that he can give additional help to Theodor. This alarm activates the fuzzy engine in order to better adjust to Theodor's personal capabilities. After Theodor completes a session, all the details are stored in the SQL server forming Theodor's personalized log files.

3.3 Scenario #3: Enjoying NOESIS

Break Time! Theodor is in the play room with various toys. Jim reinforces him to play with balls and tubes and leaves the room. Theodor puts balls of different color in the suggested tubes (see Fig. 5). With the help of RFID technology, a PC at the other end of the room simulates his actions online. Jim is careful not to disturb Theodor, so, being at his desk-room, he uses his Pocket PC, connects via Web Services to the server and asks to see the information about Theodor's actions. The amount of the alarms set by NOESIS reveals Theodor's difficulty in distinguishing the colors, making obvious the need for

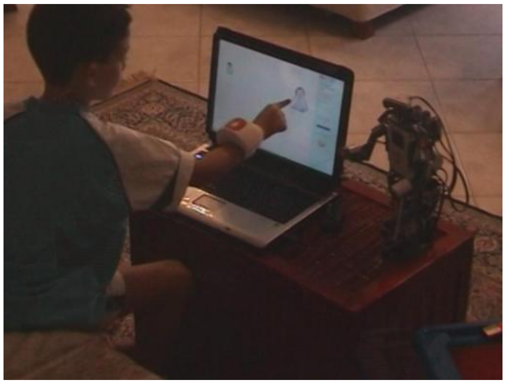


Figure 6. An example of kid's interaction with NOESIS and NOE-robot. Note the Exmocare BT2 Watch in kid's right hand, which does not prevent him to interact.

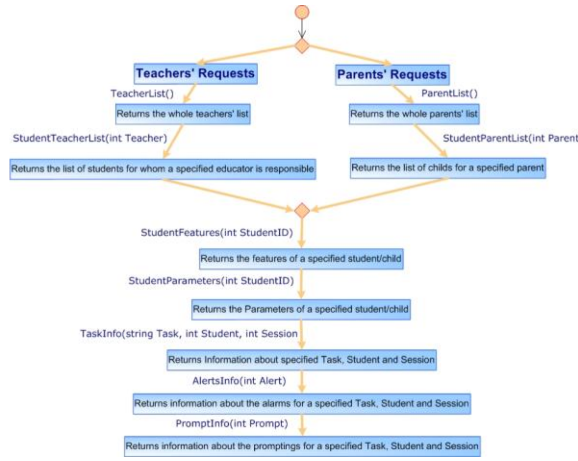
further training; hence, Jim plans to repeat the related computer task about colors with Theodor.

3.4 Scenario#4: Happy collaboration

Theodor had a great time with the balls, but started complaining because he wanted something more active. Jim comes up with another feature of NOESIS, *Robo*-NOESIS – a wireless robot, namely 'NOE'. Theodor immediately is fully concentrated to his new "friend". NOE is used as a rewarding means that reacts as Theodors interacts with the tasks of NOESIS, and tries to elevate Theodor's sociality, eliminating at the same time any obligations for social demands (see Fig. 6). NOE gives audio-kinetic feedback to Theodor and when the latter is inactive for more than 10 seconds, NOE takes the initiative to "provoke" Theodor to react and participate in the educational process.

3.5 Scenario #5: Evaluating the Day

Jim is at home and decides to review Theodor's progress. Using his Pocket PC, he downloads all Theodor's data that are available to the NOESIS server via Web Services (see Fig. 7(a)). Jim has access to all the sessions, being able to review each alarm. Choosing to compare the sessions that Theodor performed with the ball game, a comparison graph is generated, showing a slight progress at the learning abilities of Theodor across successive sessions. Viewing the patterns that Theodor created so far, Jim can decide about Theodor's creativity and imagination or repetition. Focusing on the log files of the "*Learning the animals*" task, Jim observes that a certain image, the image of a tiger, makes Theodor ex-



(a)

(b)

Figure7(a). Flow-chart of the Web services-based retrieval information of teachers and/or parents from the server, (b) Review of kid's alarm statistics and handling of the customization of the ABA material through a Pocket PC via Web services.

tremely anxious and loses his concentration. So, Jim decides to send a request of deleting this image from Theodors sessions, via Web services (see Fig. 7(b)).

Moreover, Jim has also the opportunity to monitor his class (either *on*- or *off-line*) through the class supervision tool of NOESIS (see Fig. 8).

3.6 Scenario #6: Involving Parents

Theodor's father, Bill, is at work thinking about how his son is doing at school; hence, he connects to the NOESIS server as a parent-user and asks for Theodor's updated reports. In a few seconds, he previews a history of Theodor's learning progress scores and alarm series during the current month, along with the current status of

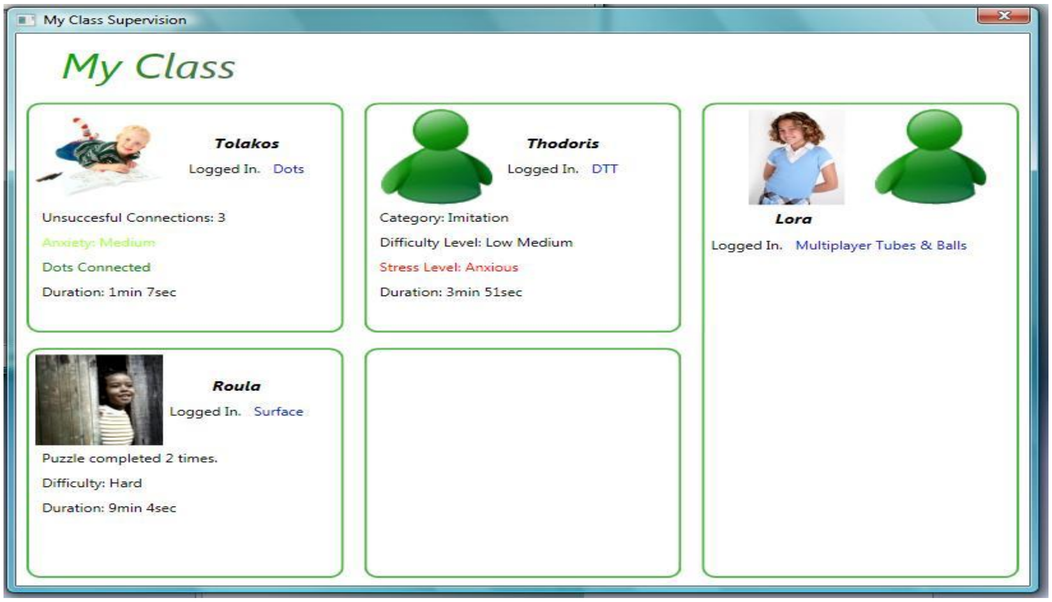


Figure 8. The class supervision tool of NOESIS.

Theodor's basic educational sections, i.e., cognitive, mobility, verbal ability, communication-imagination (see Fig. 9). Bill reinforces Jim to keep involving NOESIS in the educational procedures of Theodor.

Through the NOESIS *'Listen to the parents' voice'* common space, Bill has also the opportunity to share his views, thoughts and case-scenarios with other parents and discuss and send feedback to Jim upon specific issues and decisions.

4. Concluding remarks

The innovations behind NOESIS consist of a broader approach to the problem examined. Until now, ASD software, like BoardMaker [4] and Picture It [5], refers to educational material gathering. Using advanced signal processing and cutting-edge technology NOESIS provides an integrated educational environment which is closer to the kid's needs and, therefore, realistic and more efficient. It is the first ASD educational tool, which uses both biofeedback information and kid's response in an adaptive way that fulfills each kid's specific educational needs.

NOESIS provides the educator with flexible ways of setting, evaluating and expanding his/her educational material, combining information from the kid's real world, capturing the essence of his/her understanding abilities and adjusting his/her learning rhythm, under a vast variety of different case-study scenarios.

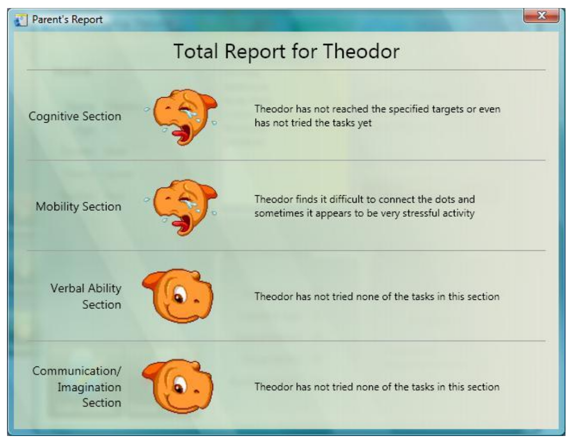


Figure 9. Parent's report for four basic sections of kid's activities.

5. References

[1] O.I. Lovaas, "Behavioral treatment and normal educational and intellectual functioning in young autistic children", *Jl of Cons. & Clinical Psychology*, vol. 55, 1989, pp. 3–9.

[2] L.M. Oberman, E.M. Hubbard, J.P. McCleery, E.L. Altschuler, J.A. Pineda, and S. Vilayanur, " EEG evidence for mirror neuron dysfunction in autism spectrum disorders," *Cognitive Brain Research*, vol. 24, 2005, pp. 190-198.

[3] Zadeh, L.A., *Fuzzy sets*, in: Dubois, Prade, Yager (Eds.), *Readings in Fuzzy Sets for Intelligent Systems*, Morgan Kaufmann Publishers, Inc. Los Altos, CA, , pp. 27-65, 1993.

[4] http://www.mayer-johnson.com:80/

[5] http://www.slatersoftware.com/autism.html

Personalised support for students with disabilities based on psycho-educational guidelines

Alejandro Rodriguez-Ascaso[1], Olga C. Santos[1], Elena del Campo[2], Mar Saneiro[2], Jesus G. Boticario[1]
aDeNu Research Group. Artificial Intelligence Dept. Computer Science School, UNED[1]
Psychobiotecnomedicine Research Group. Evolution and Education Psychology Dept., UNED[2]
{arascaso,ocsantos}@dia.uned.es,{mcampo, masterdiscap}@psi.uned.es, jgb@dia.uned.es

Abstract

In this paper we present research works we are addressing in EU4ALL project (IST-2006-034778) to enable Higher Education (HE) institutions to support and attend the accessibility needs of their students. This approach is based on integrating i) learning and ii) management of the learning in terms of workflows to support the different types of existing scenarios with a twofold objective. First, involving non-technical staff in their definition. Second, using standard-based learning management systems (LMS). A combination of design and runtime adaptations through IMS Learning Design (IMS-LD) specification is being used, following the aLFanet approach (IST-2001-33288).

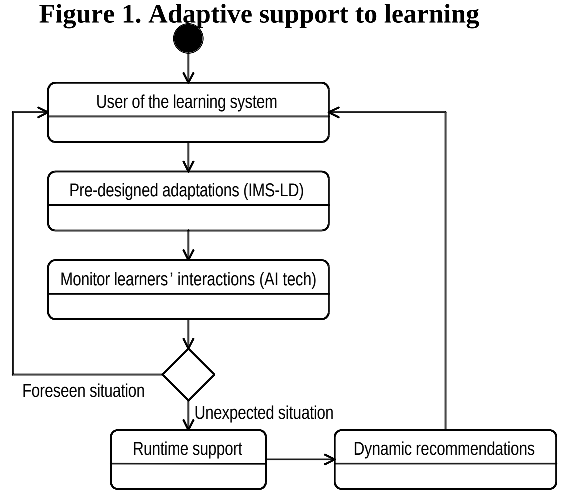
1. Introduction

Adaptation is essential in any eLearning environment since learning is, by nature, an evolving process that strongly depends on users' characteristics and their evolution over time. In particular, eLearning users have a wide variety of abilities, backgrounds, interests, level of experience on the use of resources, etc. Reaching optimal academic performance requires learning environments to adapt to individual user needs. Furthermore, in order to provide inclusive learning services, accessibility requirements have to be met. This implies considering personal needs and preferences regarding the interaction with learning contents and services. To carry out this adaptation a user model representing the user's knowledge state, preferences, learning styles, psychological profile, goals, etc. has to be constructed [1].

Moreover, previous findings in pedagogical and psychological support to students with different learning needs make use of learners' characteristics to better define the student role [2].

Our approach considers instructional design based on IMS Learning Design (IMS-LD), which guarantees pedagogically driven pre-defined adaptive learning paths for different types of users' needs. In turn, to guide user's interactions, users' behaviours are monitored over time applying artificial intelligence techniques to identify troublesome (i.e., lack of knowledge) and promising (i.e., high interest) situations and perform remediation or support actions.

Figure 1. Adaptive support to learning



In EU4ALL we are applying this approach to support HE students with disabilities. Our goal is to model learning scenarios as adaptive workflows. Two illustrative scenarios are described. One case is about supporting students with disabilities through the assessment process, while the other case is about the collaboration amongst students with functional diversity to build a project proposal through a VLE.

2. Design time adaptations

Design and runtime adaptations to support staff, teachers, students, and support services are built considering general psycho-educational strategies which are then translated into the IMS-LD specifications.

The psycho-educational guidelines and best practice material used to design the adaptations are elaborated by the psycho-educational counselling service. At the same time, a taxonomy has been elaborated to support these guidelines. Bloom's taxonomy [6] has taken as a basic reference, as it describes the atomic activities developed by the learner in the educational process.

Our taxonomy includes Bloom´s learning categories as well as additional strategies that are relevant to the learning-teaching process, i.e., cognitive, meta-cognitive, interaction, communication and affective strategies.

These strategies have been previously addressed in the literature: cognitive strategies in [7], meta-cognitive strategies in [8], communication and interaction strategies in [9], and socio-affective strategies in [10].

The application of these strategies allows the learner to undertake activities, such as contact with peers, tutor, and teachers, to ask for support from others, to receive positive feedback of his/her work, to control his/her psychological process in stress situations, etc. These strategies are applied in learning scenarios to optimize academic performance of learners.

Table 1. Taxonomy of learning strategies

COGNITIVE STRATEGIES	**TECHNIQUES**
Rehearsal	Using mnemonic activities
Organization	Diagramming the information
Codification	Identifying concepts
Elaboration	Creating analogies, making hypothesis
Synthesis	Replacing words, synthesizing paragraphs
Transfer	Using equivalent sentences
META-COGNITIVE STRATEGIES	**TECHNIQUES**
Focussing attention	Detecting only a specific type of stimulus (visual, acoustic, tactile), relating a piece of information to the learner´s needs
Planning	Scheduling (daily ritual, weekly pattern)
Monitoring and Regulating	Employing test-taking tactics.
Evaluation	Answering questions
INTERACTION STRATEGIES	**TECHNIQUES**
Cooperation	Asking for collaboration from peer learners
Clarification	Confirming the information
COMMUNICATION STRATEGIES	**TECHNIQUES**
Face / Gestures	Practising reading body language to can better understand other's reaction
Para-linguistics	Controlling voice speed, volume, fluency, tone, time
Conversational	Using appropriate language according to the environment and his objectives
AFFECTIVE STRATEGIES	**TECHNIQUES**
Self-esteem improvement	Reflecting inner critic
Change of attribution	Improving adjustment
Self-efficacy improvement	Setting realistic, clear and accessible goals
Self-control improvement	Delaying immediate rewards

These learning strategies are used to design reusable units of learning where adaptive learning flows are implemented. IMS-LD provides the necessary support to design strategies that address these particular issues, aiming to support learners who encounter barriers.

To define the learning design, a bottom-up approach has to be followed. First, the learning activities have to be defined, which are clustered into activity structures. Lessons are developed by creating activity clusters including the previously defined for each module. Activities take place in learning environments. The creation process could be described as follows. First, the learning objects have to be defined. For instance, the text of the learning materials is enriched with diagrams as an enhancement for people with hearing disabilities. Then, these learning objects are allocated to an environment, and then the environment allocated to a learning activity.

3. Learning management scenario: Support through the assessment process

The following case aims to describe the assessment accommodation service. This service [3], has been traditionally provided ad-hoc at Higher Education institutions, such as UNED. First, we describe the overall assessment adaptation process in our university, and then we detail how a student with specific needs would be supported through an adapted workflow.

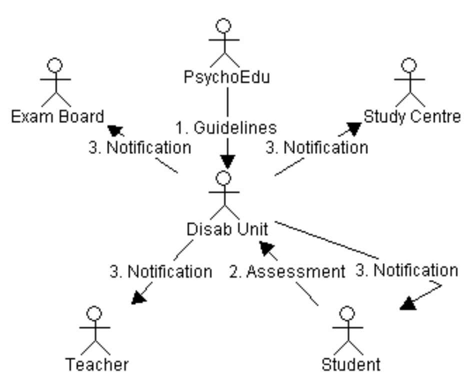
3.1 Assessment support service

The main roles involved in the assessment adaptation service are: a) The student; b) the disability support unit, c) the psycho-educational counselling staff; d) the teacher of the subject for which the exam should be adapted; e) the examination board; and f) the study centre where the exam will take place. The process could be described as follows:

1. During the enrolment process the student is informed about the accommodations available in assessment activities.
2. The student then makes a request by filling-in an application form provided by the disability support service in the institution intranet.
3. This request is received and assessed by the disability support unit, according to the accommodations requested, the student personal information, the available guidelines, and the subject characteristics.
4. The disability unit notifies on the accommodations finally approved to all the involved parties, i.e., the student, the teacher, the examination board, and the study centre.
5. The teacher, the examination board and the study centre will ensure that all the accommodations are in place for the assessment.

In order to meet administrative deadlines, an agile administrative process is required. Providing the student with a timely feedback about their request will also help to minimize the student's degree of anxiety. This will avoid the situation of students having to apply again or to contact with other university roles. Moreover, it will ensure that the assessment environment is ready by the time of the assessment.

Figure 2. Collaboration diagram for assessment support



3.2 Support to a student with attention deficit

Paula is a student who has an attention deficit disorder. As a consequence, she presents some learning difficulties such as: i) bad organization of the work, ii) difficulties to finish the daily tasks, iii) poor handling of the time, iv) problems in reading comprehension, v) problems to extract relevant information, and vi) difficulties in finishing the examination in the established time.

Because of these problems, Paula requests some exam adaptations for the courses where she is registered in, in order to minimize the negative psychological aspects that could arise during the assessment process, such as anxiety or lack of attention.

Once the student's request is approved, and all the parties are notified, the teacher consults the guidelines for anxiety reduction and attention improvement. By following the recommendations given in the guidelines, the teacher decides on the most suitable exam type for the student´s needs. For instance, a questionnaire is more suitable in order to minimize concentration loss and physical effort. Both of them are common problems when the student has to face a long exam. Furthermore, facilitators may also be allowed or provided during the assessment: e.g. availability of calculators, computer support for spell-checking, scratch paper during exams, etc. Other accommodations are granted, such as doing the exam in a separate room to minimize distractions.

The disability unit notifies the student and the rest of the parties about the accommodations and the evaluation criteria.

Furthermore, Paula may receive advice from the psycho-educational counselling service about which activities could help her in reducing anxiety in exams, and therefore optimizing her academic performance. These techniques aim to support her in comprehending exam's questions, organising her thoughts, identifying keywords and concepts when answering to essay questions.

4. Learning scenario: Collaborative work through a VLE

The second scenario consists of a group of students collaborating through dotLRN open source standard based LMS [4] to design a development project by using the collaborative extension of the Logical Framework methodology [5]. Adaptations support two students with different needs. One student is pre-lingually deafened and the other has an active learning role, but no previous experience in the Logical Framework methodology.

Next, the learning flow of this learning scenario is described. At the beginning of the course, the system provides the teacher with a list of the students enrolled in the subject. John is reported to be pre-lingually deaf. The teacher checks the system and accesses the psycho-educational guidelines in order to provide the adequate adaptations related to time, content format, recommendation for test taking, etc.

According to the psycho-educational guidelines, the teacher provides the pre-lingually deaf in advance with an executive summary of the project and the basics of the section that the student is assigned to elaborate. This information will facilitate the student to have a context´s perspective where he should develop his tasks. These documents are complemented by a glossary of terms and a dictionary of synonyms. The aim is that, by the time that the rest of the students start to carry out the practical work, the deaf student is familiarised with the work topic and terms, and understands what is the section (s)he has to elaborate.

The rest of the group students receive the request to be part of the team, the work topic, as well the section they are assigned with. They all start to work individually in their own sections. Essentially, they write their sections.

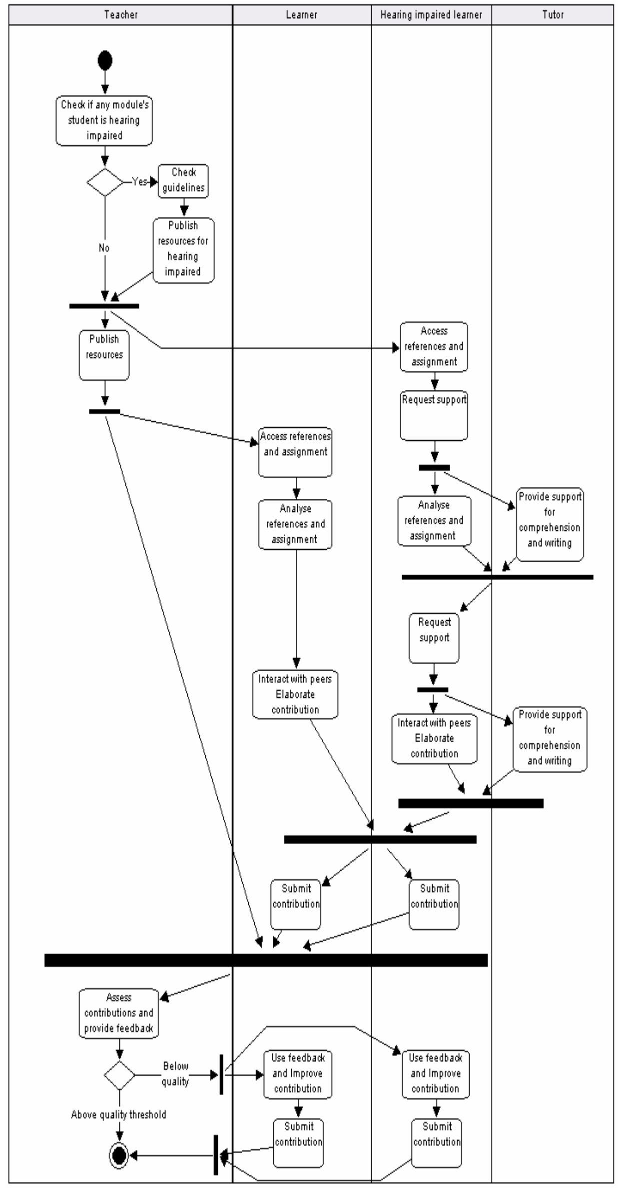
While writing, the deaf student is supported by several means: glossary, synonym dictionary, etc. The glossary of terms could be enhanced with sign language interpretation of the terms. There is also a service for support in comprehension and writing of texts where the student is supported by a tutor. They have an asynchronous communication through a forum. The student sends this information (e.g. one section that the student is assigned to write) to the tutor, who provides with some feedback and suggestions if necessary. The tutor detects problematic words and expressions, and reports them to the teacher, in order to improve the available glossary.

At a certain date, students have to share what they have produced in their sections, and they must integrate them to generate the final document. This requires that the students are able to communicate. To ensure an accessible communication among the peers, communication has to be either face-to-face (with a sign language interpreter) or through an instant messenger.

The students compose the joint document and submit it to the teacher, who carries out the evaluation, based on group and individual contributions.

There is a two-step process on evaluation. Students can ask for further clarifications and comment on the teachers´ remarks. At the end, the teacher assigns a mark to each student and closes the activity.

Figure 3. UML activity diagram



The IMS-LD Unit of Learning will include specific support for the hearing impaired student:

1. Timeline adaptation, as some environment resources will be available in advance (i.e., executive summary of the publicity project, and the basics of the assigned section).
2. Additional resources will be 'visible' (i.e., dictionary of synonyms, asynchronous communication with tutor).
3. Accessibility to learning objects through personalisation of contents. The glossary of terms will include redundant information (i.e., images and sign language equivalents).

5. Runtime adaptations

As introduced in section 2, both scenarios are translated into environments, where different activities are carried out by the different user roles, as defined by IMS-LD. Properties may also be defined and used in the workflow conditions to build the adapted path for each particular user. However, since not everything can be defined in advance, there is a need for a dynamic support at runtime. At runtime, users are requested to follow the workflows of activities defined in IMS-LD. However, the student might encounter an impasse that has not been covered in the design.

For the learning management scenario (i.e. support for the assessment process) considering the previous experiences of other learners following the process for the assessment adaptation, the system may recommend the most appropriate alternative at a certain point. For instance, although the design (defined in the IMS-LD guidelines) may allow users to ask about the status by phone or e-mail, the system may explicitly recommend Paula to write an e-mail and even provide her with a text proposal for the mail contents, which she should revise and complete, if needed. In this way, the effort an anxiety of having to make the request from scratch or of having to explain on the fly the request by phone is reduced.

For the learning scenario, “lack of knowledge” and “high interest” situations can be detected. In this case, dynamic support can be provided. In particular, the system can look for similar students (based on their user model features) that overcame difficulties when performing the same activity and recommend the current student to do the action that some similar student did. For instance, she may have read a forum message where detailed explanation is given.

6. Work in progress

In EU4ALL project we are extending the aLFanet approach to cover inclusive scenarios in HE. In this sense, we are currently clarifying i) how to manage the user features in IMS-LD specification, considering that accessibility was not addressed in the origin of the specification (i.e., implications and interoperability with IMS AccLIP and ISO PNP initiatives [11]), ii) the level of compliance of IMS-LD units of learning with available LMS players, and iii) how to involve professionals with a non-technical background (like those specialized in the psycho-educative guidance) in the design of the scenarios.

7. Acknowledgments

This work was funded by the EU under grants IST-2006-034778 (EU4ALL project) and IST-2001-33288 (aLFanet project). The opinions herein are those of the authors and not necessarily those of the funding agencies.

8. References

[1] J. G. Boticario, O. C. Santos, “An open IMS-based user modelling approach for developing adaptive learning management systems”. Journal of Interactive Media in Education (JIME), September 2007

[2] C. O. de Mora, A Derycke “Pedagogical patterns and learning design: When two worlds cooperate” USTL/CEFET-CE. Workshop UNFOLD/PROLEARN, 2005

[3] O. C. Santos, J. G. Boticario, E. del Campo, M. Saneiro. “IMS-LD as a workflow to provide personalized support for disabled students in Higher Education institutions”. Proceedings of UM 2007 TUMAS-A workshop, 2007

[4] O.C. Santos, J.G. Boticario, E. Raffenne, R. Pastor. Why using dotLRN? UNED use cases. FLOSS International Conference, 2007.

[5] O.C. Santos, A. Rodríguez, E. Gaudioso. J.G. Boticario “Helping the tutor to manage a collaborative task in a web-based learning environment”. Proceedings of AIED 2003 Workshop Towards Intelligent LMS, 2003.

[6] B.S. Bloom. Taxonomy of Educational Objectives. Book 1: Cognitive Domain. White Plains, NY: Longman, 1984.

[7] Robertson, I. T. (1985). Human information-processing strategies and style. Behavior and Information Technology, 4 (1), 19-29.

[8] Ellis, E.S. (1993). Integrative strategy instruction: A potential model for teaching content area subjects to adolescents with learning disabilities. Journal of Learning [6]

[9] Carmel, D. and Markovitch, S (1998) . Model-based learning of Interaction strategies in Multi-Agent System. Journal of Experimental and theorical artificial intelligence, 10, 309-332

[10] Brown, D. (1987) Principles of Language Learning and Teaching. New Jersey: Prentice Hall.

[11] O. C. Santos, A. Rodríguez Ascaso, J.G. Boticario, L. Martin. “User modeling for attending functional diversity for ALL in Higher Education”. Proc. Web Information Systems Engineering, 453-458, 2007.

Inclusive, Adaptive Design for Students with Severe Learning Disabilities

Matt Harrison
Portland College, UK
mharrison@portland.ac.uk

Claire Stockton & Dr Elaine Pearson
University of Teesside, UK
c.m.stockton@tees.ac.uk
e.pearson@tees.ac.uk

Abstract

Young adults with severe disabilities and learning difficulties (SLD) have very limited access to appropriate learning resources. Their unique individual needs and requirements prevent them from accessing traditional methods of online learning, and resources tend not to be age appropriate. The majority of SLD learners has difficulty accessing a computer with standard peripherals such as a mouse and relies on assistive technologies (e.g. switches) to do so. Each learner tends to have specific needs that must be addressed in order to provide an accessible and adaptive platform for learning. The aim of this research project was, with the assistance and support of the learners and their tutors, to design and develop an adaptable and inclusive online learning environment specifically catering for the needs of young adults with SLD. Each stage of development was prototyped and assessed in the college environment to ensure the needs of the learners were thoroughly addressed.

1. Introduction

The aim of the Portland Partnership project was to develop prototype ICT-based software and curriculum content to better meet the needs of adult learners with a range of physical disabilities and associated learning difficulties. The Partnership was funded as part of the European Social Fund's 'Equal' initiative which sought to develop innovative ways of ensuring participation in lifelong learning; potentially opening doors to the labour market. It was led by Portland College - a national specialist college in Nottinghamshire, England, for learners with physical disabilities and associated learning difficulties, and involved partners from Further and Higher Education, as well as the private sector. The University of Teesside was responsible for conducting an analysis of user requirements and designing and developing the adaptive and accessible learning environment itself. This paper provides an overview of the project and its findings.

The rationale behind the project grew from a group of practitioners who were no longer prepared to accept inappropriate resources designed for mainstream learners. Its initial focus was to identify the needs of a diverse group of learners with disabilities and design specifically for their needs. Extensive prototyping, user-testing and dissemination activity demonstrated that this was the most appropriate approach.

2. Learner Characteristics

The specific target user group for the project were young adult learners from 16 years upwards at pre-Entry level [1]. The differing needs and requirements of these learners make it difficult to portray a typical learner, however DfES describe these students as being "capable of learning, but they will have profound intellectual impairments and will require very specialised teaching [2]."

The varying abilities and disabilities of this learner group suggest that each learner has unique needs in terms of accessing Information Learning Technology or learning itself. The characteristics of a learner with profound and multiple disabilities vary greatly from one learner to another, but may include:

- limited or no sight e.g. lack of depth perception or reduced visual fields
- limited or no verbal communication e.g. dysarthria
- learning difficulties e.g. low levels of literacy and numeracy (The learner may be learning to recognise individual letters of the alphabet or count to five.)
- physical disabilities e.g. poor or no fine motor skills or quadriplegia

The learners involved in the project were predominantly residents and day students at Portland

College. All learners studied a range of basic skills and life skills, including communication, numeracy and literacy and daily tasks aimed at increasing their level of independence. In all cases, the learners in the project stated that they wanted parity with their non-disabled peers and therefore felt that they had a fundamental right to access ICT-based resources and tools.

Coinciding with the project's inception, developments in legislation placed increasing pressure on educational institutes to be more inclusive, so that all learners, regardless of ability, were given the same learning opportunities. The legal requirements opened the gates to inclusive and accessible online learning for all learners, particularly those with severe learning disabilities. One of the main points in the Special Educational Needs and Disability Act (SENDA), 2001 stated that: "If a disabled person is at a 'substantial disadvantage', responsible bodies are required to take reasonable steps to prevent the disadvantage [3]."

Many of the learning resources targeted at learners with SLD were not age appropriate or compatible with assistive technologies, whereas there were many resources designed specifically for more common disabilities such as dyslexia. This was an issue which needed to be addressed as students with SLD had very specific requirements and were in greater need of these resources to enable them to gain basic skills.

The pre-Entry-level learners were also heavily reliant on pictorial symbols and images which were integral to their communication and general understanding of language. There are many different symbol sets available, and although there is no universal language, using symbols appropriately will aid the learner and give context to a word, phrase or scenario. Below are examples of three such symbol languages.

Figure 1. Widgit Picture Communication Symbols

Figure 2. Widgit Rebus symbols

The nature of the problems encountered by this group of learners had a direct impact on their ability to make use of online learning resources. The first barrier to electronic learning materials was access to the resources themselves. A combination of both physical and cognitive disabilities meant they may were unable to use standard peripherals such as a mouse and keyboard, and instead required the use of assistive technologies such as switches and touch screens to operate a computer.

There was a paucity of standalone electronic learning resources, and little to no access to online learning materials for learners over the age of sixteen with SLD. Many educational software programmes did not meet the needs of these learners as the online and standalone resources available tended not to cater for their exact access requirements. Furthermore, a high percentage of the software that was accessible was not age-appropriate.

3. Exploiting the potential of online learning

Online learning environments now form a standard part of teaching and learning for Further and Higher Education students and practitioners within the UK. They provide opportunities for communication between learners and tutors, peer learning and access to course materials and wider resources. However, they remain largely inaccessible to those whose physical disabilities prevent them from using standard computer equipment, or to those with low literacy levels.

The project aimed to support and promote online communication and learning. A Virtual Learning Environment (VLE), therefore, suited the project as it would allow an 'anytime, anywhere' approach to using technology, learning and communication. Furthermore, such a system would also ensure that roaming profiles were used, meaning that a learner's accessing preferences would automatically be loaded upon login.

From the outset, the project sought to promote meaningful use of ICT. The online environment and learning materials were designed to promote basic ICT use, as well as the development of literacy, numeracy and communication skills. Appreciating that computer-based learning could be a highly motivational, flexible and enabling solution for many learners, not least those with disabilities, we questioned the use of ICT for its own sake and promoted it as a creative tool at the tutors' disposal, rather than as a substitute for good teaching..

4. Learner Profiles

Participating colleges provided an overview of the needs and requirements of this unique target audience. To meet with ethical requirements these were made anonymous. Much of this information was transferred to the design and implementation of the adaptive VLE to ensure accessibility and adaptability for each learner. Baseline observations formed a criterion of the needs and preferences of the learner in terms of software requirements for delivery of appropriate learning resources.

Detailed profiles of each learner were created based on the information gathered from the college databanks and baseline observations. These unique individual profiles were created to provide specific access to the VLE for each individual learner. The information provided the students' preferences or access requirements which included:

- Personal Information:
    1. Name
    2. Photograph
    3. Email contact addresses
    4. Class/Tutor Group
- Layout and access requirements:
    1. Background colour
    2. Font colour
    3. Text
    4. Symbol Set
    5. Audio
- Access Device:
    1. Assistive Technology
    2. Scan Speed

The hypothesis for these learner profiles is that they ensured adaptability and accessibility for each user by meeting their unique needs, providing that the VLE could support them

By designing the VLE so that it could be tailored for each learner according to their profile, ensured it became adaptable to meet the individual needs and preferences of the target user group. The development of these learner profiles, with the aid of the information gathered from the baseline observations, also ensured that learners were able to have the screen display and layout of their choice, and also compatibility between the VLE and their preferred input device. Using their own personal information and choice of symbol set increased the personalisation of the interface yet further. An essential factor of the learner profiles was that, through the tutor tools function, tutors were able to use the information to monitor which learning materials each individual could access within the VLE. This was particularly important in ensuring that learners could benefit from individual learning strategies. It was hoped that the adaptability of the VLE would transfer to other learners in mainstream education regardless of whether or not they had a disability.

5. The design of an accessible learning environment

Research gathered from learner observations, baseline observations and focus groups with learners and tutors was carried out in accordance with the ISO 13407 standard (human-centred design processes for interactive systems): "Understanding and specifying the context of use, specifying the user and organisational requirements, producing designs and prototypes and carrying out a user-based assessment [4]." The data gathered from these interactions with the learners and tutors helped to form a catalogue of the specific functionality and entry requirements the VLE would need to encompass for it to be adaptable and accessible to the needs of these learners. This led to the development of the design criteria for the Portland Plus VLE, which included:

- Ensuring appropriate language was used for each learner i.e. options of symbols, symbols and text or text only.
- Compatibility with adaptive technologies for those unable to use a mouse or keyboard.
- Providing built-in audio and visual clues for additional learning support.
- Providing an adaptable interface in terms of screen layout, including the provision for font and colour adjustments in order to support those with visual impairments.

The criteria for the design ensured that the VLE would be adaptable so that it could be adapted to meet the unique needs of each individual learner.

The Portland Plus online environment met the needs of those learners with low literacy levels via symbol-supported text and speech output. Using the environment and its contents enabled users to become familiar with the standard navigation conventions associated with ICT-based materials e.g. using an 'X' to close a program down or using an arrow to indicate 'back'. In addition, everything could be operated using one or two switches as an alternative to keyboard or mouse, making it accessible to learners with poor motor skills.

The VLE contained the standard features found in most mainstream VLEs, including a secure login system, communication tools, timetable and access to tailored learning resources.

At every stage, learners and tutors were involved in the development of the project's outputs. Discussions about initial ideas, focus groups, and the trialing and evaluation of iterative prototypes all provided unprecedented opportunities for learner and practitioner empowerment and engagement. For example, learners stated that one of their major frustrations was not being able to log on to a computer more independently. This led to the development of the accessible login screen for our online environment, which was welcomed enthusiastically by learners and tutors alike.

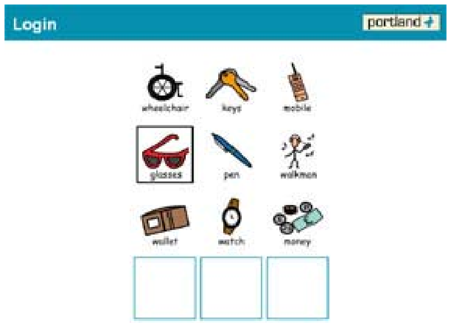


Figure 4. Login screen - Enter Password

The login process was an essential first point of contact for the learners. Learners were unable to log in themselves to any other system. It was important to make this process as accessible and autonomous as possible for the learner as this was the first step in independent online learning.

The input methods for navigation and selection included the development of a scanning mechanism for switch users. Single-switch users were given a scan bar - a coloured box that moved in a linear pattern from one symbol to the next within the display screen. The speed of the scan bar was controlled within the tutor tools function. When the scan bar was over the required symbol the learner used their switch to select that symbol. Two-switch users were able to move the scan bar in a linear pattern independently, by using one switch to move the scan bar and another switch to select the chosen symbol once it was highlighted by the bar. There was also a mouse input preference for mouse users and a mouse override for tutor intervention. The design ensured that it was also compatible with touch screens and most other assistive input devices such as tracker systems and head pointers.

As well as providing access to tailored learning resources, the VLE also offered a built-in symbols-based email system. The email tool was developed to offer learners the opportunity to send pre-determined sentences from a range of subject categories and topics via email to their peers and tutors. It was hoped that with further research that this design could be developed so that emails could be sent to external addressees with appropriate symbol translation and with interoperability with other standard email systems.

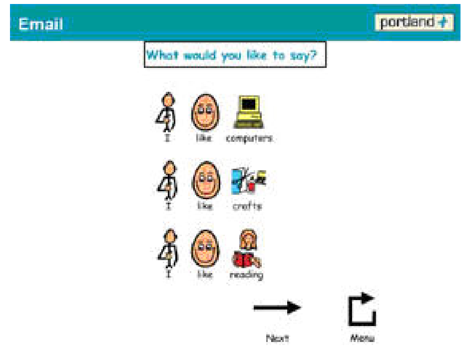


Figure 5. Email send - What would you like to say?

The timetable function was designed to display information in small, absorbable sections. As many of the learners were unable to understand or read the time, symbols representing periods of the day were employed to break up the daily timetable. Each timetabled activity was illustrated with an appropriate symbol as well as supported by text and audio. Should the VLE be developed further, more advanced learners may be given more detailed and expansive timetables e.g. a weekly table.

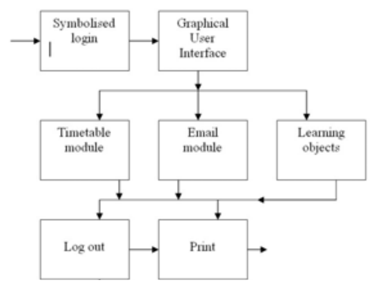


Figure 6. Overview of VLE learner interface

The tutor tools were an intrinsic part of the design and functionality of the VLE which ensured its adaptability and accessibility to Pre-Entry-level learners. These tools enabled a tutor to have complete control over what and how learners had access to within the environment. The tutor tools gave the tutor the ability to adapt the design and functionality to meet the needs of the individual target learners. The administrative tutor tools allowed the tutor to input all relevant information for each learner in a group, this included:

- Adding an individual learner to a group, which involved inputting details from the learner profile, comprising of:
    - Class allocation
    - Symbol set
    - Language level
    - Allocation of symbols password

- Selection of display colours
    - Selection input device and settings
    - Learner's photograph
    - Audio requirements
- Class management
- Editing tutor details
- Allocation of functions/learning materials

At each stage of the design process, iterative prototypes were tested with the learners within the college environment. Participant observations were recorded onto video and transcribed and the data collated. These findings shaped the final VLE design.

6. Conclusions

The unique functionality and features of the VLE has resulted in an accessible and adaptable learning environment which meets the needs of learners with severe learning difficulties and physical disabilities. The design encourages a greater level of independence for the learner by ensuring that the VLE and the learning objects are accessible with the appropriate input device, language tools and layout required by each individual user. Independent learning through the VLE may encourage learner empowerment. Learners now have a gateway to more appropriate and accessible learning resources. Improved access to resources should further encourage independence and a willingness to use and explore the VLE features, which will potentially lead to an increase in academic attainment. The collaborative email tool offers an alternative means of communication and will support the development of communication skills which could lead to increased learner empowerment and independence. The flexibility and level of control within the tutor tools ensures the required adaptability and functionality of the VLE for its learners. This is a distinct benefit to all tutors as they have increased levels of monitoring and assessment over individual learners, thus ensuring that their academic and learning needs are met.

The current VLE specification has been designed exclusively for the lowest levels of academia - for learners aged 16 years plus at pre-Entry. As the current design is tailored specifically to this target user group it may be inaccessible to other groups of learners with disabilities, such as those with severe visual impairment or blindness.

As part of the evaluation procedure feedback was taken from a sample of the target user group; responses included:

- "I like it reading out to me", Student A
- "I would like to send emails to my mum because I can't at the moment", Student B
- "I think it would be good for people with limited hand movement" student B
- " I did it all by myself" Student C

In order to claim that the VLE design is fully accessible to most learners up to and including those in mainstream education, it may require different interface designs for the front end and need to support other assistive technologies. However, developing an accessible VLE that can benefit learners with learning difficulties and/or disabilities may also benefit other users, as accessible software can often be the most usable software. The level of adaptability of the VLE to meet other learner needs (including those of the elderly) is an area that is hoped to be explored in future research.

7. References

[1] DfES (2001) *Adult Literacy Core Curriculum including Spoken Communication*, London DfES

[2] DfES (2000). *Freedom to Learn: Basic Skills for Learners with Learning Difficulties and/or Disabilities.* London DfES

[3.] *Special Educational Needs and Disability Act 2001 (SENDA), Chapter 10* [online] Available from www.hmso.gov.uk/acts/acts2001/20010010.htm [Accessed January 2008]

[4] *ISO/IEC. 13407 Human-Centred Design Processes for Interactive Systems*, ISO/IEC 13407: 1999.

Pedagogical Perspective on Inclusive Design of Online Learning

Éric Bel and Emma Bradburn
Centre for Learning & Quality Enhancement,
University of Teesside, United Kingdom
e.bel@tees.ac.uk, e.bradburn@tees.ac.uk

Abstract

This work focuses on the pedagogical perspective that teachers in Higher Education adopt when developing accessible online learning experiences. To date the research has reviewed various approaches toward implementing accessible online learning and guidance offered to Higher Education teachers. This was found to be mainly targeted toward technical accessibility for developing online resources with less on providing accessible pedagogy. Approaches that do consider the teaching context focus heavily upon learners' needs. A simpler model is proposed which places inclusive learning as the main aim and incorporates the support needs of teachers beside those of the learners. Indeed, initial research has shown that teaching staff require help in creating accessible learning experiences, not just resources.

1. Introduction

In Higher Education (HE) there has been a shift of emphasis from 'teacher' to 'learner-focused' approaches to educational practices. Similarly, in designing computer-based educational resources, the focus has shifted from technology and its potential to starting from the learners' individual needs to ensure accessibility. We argue in this paper that accessible design approaches should be underpinned by effective pedagogy, that 'learning' is therefore at the centre of the system that encompasses learner, technology and discipline learnt, and that the teacher has a key role to play in this system.

In fact, we advocate an approach to designing accessible computer-based learning and teaching resources that encourages *inclusive* learning, i.e. learning that does not discriminate against anybody in terms of educational strategies. For this to happen, HE teachers need to be supported to engage with accessibility issues in a *systemic* manner and to integrate resources in a wider pedagogical framework.

2. Perspectives on Accessibility

There are two major theoretical perspectives for meeting the needs of learners with special needs: medical and social. The medical perspective is concerned with responding to the specific needs of people with disabilities through adapting the design of a product or service to accommodate for individual needs. These approaches mainly discuss 'accessibility'. The social perspective is linked to the ideal of the egalitarian society and involves planning to meet the needs of all people (including different cultures, ages as well as disabilities) in the design of products to be 'inclusive'.

Both perspectives are enabled with design paradigms that provide solutions to a design problem (such as responding to the needs of disabled people) through a model or approach.

The majority of guidance for teaching staff in delivering accessible online learning has been predominantly influenced by Web design paradigms with technical outcomes. We will now discuss how such accessible Web design perspectives emphasise technical access to resources in Higher Education.

3. Approaches to Web Accessibility in Education

Since the introduction of the Special Educational Needs and Disabilities Act [1] in the United Kingdom specific guidance on creating accessible learning resources has emerged within an educational setting that have incorporated Web standards described, for example in the Web Accessibility Initiative (WAI) [2] content guidelines. The WAI provides a technical concept of accessibility and emphasises access to the Web and interaction with content; as their definition states, ‘Web accessibility means that people with disabilities can perceive, understand, navigate and interact with the Web’. The WAI guidelines and recommended techniques do not provide specific support for teachers working with learners, but guidance for Web developers working with Web content.

In our view we need to move beyond just considering Web standards and toward a *pedagogical* perspective of accessibility. Academics will require appropriate support to ensure that pedagogically sound activities and resources are not immediately discounted because they are potentially non compliant to standards. Approaches are emerging which seek to enable teaching staff to develop accessible solutions to prepare for the diversity of learners’ needs. Two such approaches are now discussed.

3.1 Holistic Framework

The ‘holistic framework for e-learning accessibility’ [3] incorporates a number of elements that impact on accessible learning. It considers the usability of resources, pedagogical aims and infrastructural and resources issues, with the aim of creating solutions that are appropriate to learners’ needs.

Figure 1: A holistic framework for e-learning accessibility

As can be seen from figure 1, the holistic approach places learners’ needs at the centre of the accessibility framework.

3.2 Accessibility Challenges to Blended Learning Model

In a blended learning environment the teacher combines electronic modes of delivery and traditional teaching methods in order to provide an effective learning environment in which the learners can meet the required learning outcomes. The model for ‘identification of challenges to blended learning’ [4] provides a starting point for identifying key issues or challenges to accessible learning, and instigates a solution from a socio-cultural rather than a medical perspective.

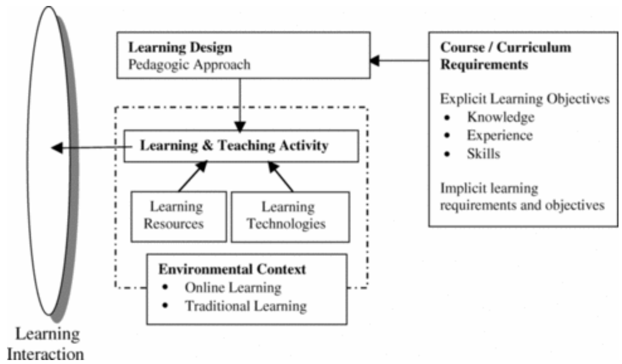


Figure 2: A model of the challenges to blended learning: from the teacher’s perspective

The model has consideration for the perspectives of both the learner and the teacher. Shown in figure 2 is the teacher’s perspective, the role of which ‘is to facilitate learning, through the facilitation of learning interactions’ [4]. From the teacher’s perspective, the model includes many essential aspects: the impact of the curriculum, learning designs, learning activities and the environmental context on the learning interaction.

4. Evaluation of Accessible Approaches

We suggest that the two models discussed above go some way to including learning into ‘accessible’ online teaching practices, but then still overemphasise learners’ needs and interaction with resources. Both the holistic and ‘blended-learning’ perspective for accessibility include the teacher as decision maker for developing activities that match the needs (or interaction requirements) of learners, but they do not include guidance for the teacher in the process.

The teacher in the constructivist role of facilitator requires support to make appropriate decisions that facilitate *effective* learning, especially as learners’ needs are diverse and often develop in unpredictable ways.

Approaches to accessibility are poorly supported by learning theory, being predominantly based upon learner-resources interaction, and focus on providing staff with the technical skills to develop more accessible resources rather than more inclusive learning. As there are many forms of online learning activities that require a wider range of interaction requirements [5], approaches need to consider more than access to resources.

In fact, the previous emphasis on Web standards has influenced responses to accessible online learning as a technical problem, to be solved via the implementation of technical adaptations to resources. We agree that all online resources should be developed to be as accessible as possible, however, the role of teachers is to provide inclusive and effective learning opportunities, and not necessarily to develop 'compliant' Web resources.

5. Accessibility Practices in Education

Previous studies on accessible teaching approaches have identified barriers for teachers and support issues. An earlier survey of accessibility practices found low awareness of WAI guidelines [6]. Furthermore, an evaluation of teachers practices' following on from staff development workshops (centred on awareness raising of disability issues and Web authoring skills) reported 'little evidence that teaching staff have taken the issues on-board in long-term practice' [7].
More recent research has found that 'the most significant among the barriers reported were the lack of an inclusive mindset, lack of knowledge about pedagogy, high teaching loads, and lack of time for instructional development' [8]. Our work follows on from such research and also identifies the range of practices across our institution. Furthermore, we have asked teaching staff about their concepts of accessibility and support issues in developing accessible online learning.

6. Study of Accessibility in a Higher Education Setting

To ascertain the required support that HE teaching staff need in implementing accessible pedagogy and to develop a model for such support, a survey tool was employed amongst teaching staff to establish current accessibility practices. This was followed by interviews to establish their support needs in developing inclusive learning experiences.

6.1 Accessibility Practices

A survey tool was distributed amongst an opportunity sample of teaching staff at the University of Teesside from across each of the six Schools encompassing a wide range of subject areas. The survey was distributed both on paper and through an online survey tool (StellarSurvey.com). The respondents (n=70) were skewed towards the School of Health and Social Care, the largest School within our institution.

6.1.1 Definitions of Accessibility. Teachers were asked to define what 'accessibility' means to them. Their definitions are broadly categorised into two groups: those who regard accessibility as an important parameter in providing a learning experience and *opportunity* to learn and those who see it as the *provision* and *access* to learning resources. This suggests that many teachers see accessibility as a learning issue but that others are aware of problems with access to resources.

6.1.2 Awareness of Disability. Teachers' awareness of learners having a disability is very high in our survey (84%).

6.1.3 Roles and Responsibility. Most teachers see themselves as responsible for adapting their own learning resources for accessibility. However, they also see others as responsible, in particular colleagues with the role of coordinating the requirements of disabled learners in addition to software provision, the learners themselves and central support units. The range of those with 'responsibility' also indicates the wider community in which the teachers work and suggests both potential and actual support mechanisms currently available for providing accessible learning. As one respondent commented, 'everyone is involved, it is a team effort'.

6.1.4 Online Accessibility Practices. Teachers report that they have an awareness of online accessible practices. However, whilst most say that they regularly provide resources in advance, in multiple formats and with consideration of colour contrast, many do not implement techniques recommended in the WAI guidelines such as Alternative Text Descriptions (ALT), text summaries or captions to media. This suggests a lack of ownership of the more 'technical' aspects. For example not providing ALT tags on online images suggests that teaching staff have little awareness of its function or how to apply it to images, or they do not see the relevance of descriptions on image resources for educational purposes. The types of learning resources that teachers develop themselves mainly includes digital presentations and word-processed documents. Resources are more widespread than online activities supported through the institutional online environment. Discussion boards are identified as the most used communication activity.

The results overall indicate that actual practices are not as high as reported awareness in relation to accessibility.

6.2 Support Provision

Nearly all the respondents to the questionnaire say that they would be more likely to adjust learning resources for accessibility if they had further support to do so (84%). The attitudes for the suggested preferred support provision are very positive. Perceived as the most useful are 'expert advice', 'a technician' and 'online templates'. Guidelines and workshops are rated as slightly less useful and some teachers indicate that they do not understand the meaning of 'pedagogic planning tools'. Follow-up interviews were conducted to define further appropriate support options. They identified that the first source of support for most teachers is their peers or expert advice (for example from an E-Learning team), primarily due to the speed of response and high levels of individual support. Most felt that they would benefit from guidelines and workshops but only if timely and closely related to their own circumstances.

The majority of teaching staff did not initially plan for accessibility requirements. Some, especially those from more technically aware computing backgrounds, implemented 'basic' design considerations; for example using recommended fonts and text sizes. Some indicators of initial planning for accessibility via pedagogy were identified:

'I use a lot of different teaching methods so I hope that by providing a wide approach or a variety of learning materials this makes it more accessible.'

Another interviewee tended to realise that there was an access problem when responding to the specific need of a learner:

'I dynamically might produce something or change things there and then, or if I can't do that I'm thinking about next year, can I maybe do something differently.'

This suggests that responding to a particular need can lead to a more planned and *inclusive* approach.
The interviews also show a shift in educational practices from a traditional lecture and seminar approach to a more project- and activity-focused approach. This change brings its own challenges and teachers' expressed concerns about overloading learners and finding 'the right balance' when designing learning activities and varied pedagogical approaches. This further confirms that staff need support in moving toward a more constructivist learning environment.

6.3 Summary of Results

This research suggests that, in our institution, practices such as providing alternative formats in advance and not on request are on the increase, in particular offering alternative audio resources and allowing learners to record work orally. There are early indicators of emerging inclusive practices amongst some teaching staff, mainly as a consequence of heightened awareness from responding to learners' specific needs. Such awareness raising results in a better planned approach for 'next time' and a consideration of 'how to do things differently', leading to the provision of alternative forms of resources. The results support previous studies in the lack of 'inclusive mindset' [8] being a barrier to inclusive practices amongst some teachers. This study also highlights the problem teachers have in implementing the WAI guidelines and specific techniques into their own educational practices. In addition we found a lack of planning for inclusive learning experiences at the module design stage across a wide range of subject areas. These findings support our proposal that there is a need for further staff support to develop such an approach.

7. Pedagogical Perspective

We propose that as well as the medical and social perspective discussed, in an HE context there is a need for a pedagogical perspective on accessibility for teaching staff to respond effectively to the diverse needs of learners. The pedagogical perspective emphasises learning and the design of an accessible curriculum. Technical accessibility of resources is also included but only as a meaningful aspect of a well designed curriculum that aims to meet the *learning* needs of learners.

7.1 Effective Curriculum Design

To achieve the aim of accessible pedagogy, a solid pedagogical framework is required. Biggs's, 'constructive alignment' model [9] describes effective pedagogical design as one which provides consistency between the curriculum, the teaching methods, the learning environment and assessment procedures, and how together they scaffold learning. The model emphasises the importance of defining the learning outcomes and designing learning activities that give the learners the opportunity to learn. Biggs uses the term 'constructive alignment' to indicate an assumption that the alignment process or design decisions should be based upon a constructivist framework. This model emphasises the role of the teacher not only as a facilitator of learning, but, more importantly, as a designer and 'scaffolder' of learning opportunities. We suggest that a model of learning-centred accessible pedagogy needs to be based on such an approach to curriculum development.

7.2. Proposed Model

The research advocates a paradigm shift in relation to the way accessibility is conceptualized in HE. A simple model is proposed in figure 3 which emphasises effective learning as the primary objective of any design algorithm.

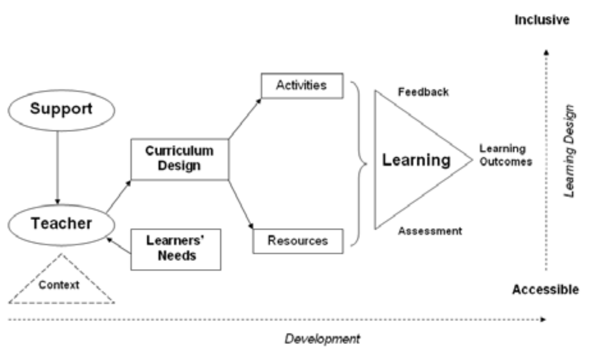


Figure 3: A pedagogical model of inclusive learning design

Underpinning this model is the need to promote acceptance of accessibility as integral to *any* design of *any* learning opportunity in *any* context for *any* learners. HE teachers should be helped to reframe their conceptions of 'accessibility' into a pedagogical perspective which emphasises design of an *inclusive* curriculum.

10. Conclusion

Staff development about accessibility in education is poorly supported by learning theory. Training tends to provide staff with technical skills to build increasing access into resources. Much accessibility advice is about learner-resources interactions and current approaches to educational development in e-learning are predominantly focused upon creating accessible *materials* and the support needs of the learner. This research promotes the development of planned inclusive *teaching* practices that foster constructivist learning, which Papert and colleagues describe as 'constructionist' [10].

References

[1] Special Educational Needs and Disability Act (2001) http://www.opsi.gov.uk/acts/acts2001/ukpga_20010010_en1, last accessed March 2008

[2] Web Accessibility Initiative (WAI) www.w3.org/WAI/, last accessed March 2008

[3] Kelly, B., Phipps, L. and Swift, E. 'Developing a holistic approach for e-learning accessibility', *Canadian Journal of Learning and Technology*, (2004) 30 (3).

[4] Draffan, E. A. and Rainger, P. 'A model for the identification of challenges to blended learning', *ALT-J*, (2006) 14 (1). pp. 55-67.

[5] Garrison, D. R. and Anderson, T. *E-Learning in the 21st Century*. RoutledgeFalmer. (2003)

[6] Sams, L. and Yates-Mercer, P. 'The Web for students and staff with disabilities: visual impairment, dyslexia and motor impairment' (2000) http://www.dmag.org.uk/resources/casestudies/samsymfull.asp, last accessed March 2008.

[7] Pearson, E., and Koppi, T. 'A Pragmatic and strategic approach to supporting staff in inclusive practices for online learning'. *Proceedings of the 23rd annual ASCILITE conference*. (2006) , pp.639-646

[8] Moriarty, M, A. 'Inclusive pedagogy: teaching methodologies to reach diverse learners in science instruction' *Equity & Excellence in Education*. (2007), 40 (3) pp252-265.

[9] Biggs, J. *Teaching for quality learning at university*, 2nd Edition, Society for Research in Higher Education & Open University Press, Berkshire (UK), 2003.

[10] Papert, S. *Situating constructionism*, in I. Harel and S. Papert (eds.) *Constructionism – Research reports and essays 1985-1990*, Ablex Publishing Corporation, New Jersey (USA), 1991.

Primary School Music Education and the Effect of Auditory Processing Disorders: Pedagogical/ICT-based Implications

Georgia N. Nikolaidou[1], Vasiliki Th. Iliadou[1], Stergios G. Kaprinis[1], Leontios J. Hadjileontiadis[2], and George St. Kaprinis[1]
[1]*3rd Dept. of Psychiatry, AHEPA University Hospital,*
[2]*Dept. of Electrical & Computer Eng.,*
Aristotle Univ. of Thessaloniki, GR 54124 Thessaloniki, Greece
msa0848@uom.gr; viliad@auth.gr; leontios@auth.gr

Abstract

Primary music education introduces children to the world of sound and music. For some children, however, auditory process disorders (APDs) act as a barrier to the comprehension of the sound elements, like rhythmic motives, variations, etc. The effect of APD in music perception is often neglected within classroom activities. This paper tries to shed light upon this effect, by focusing on duration comprehension. Experimental results from APD testing in pupils (9-12 yrs) from three Greek primary schools show that age influences the duration pattern sequence perception. Moreover, sensitivity in spatial sound information is increased in the age of 10 yrs. These results initiate some implications for ICT-based approach in music education that would foster adaptation to pupils' special needs during the educational process.

1. Introduction

The learning environment in primary classrooms provides a psychologically safe, secure and stimulating climate for children. This is further sustained when creative educational processes evolve, like those in music education. Primary school music educators aim at bringing the world of sound into the classroom, so every child has the opportunity to play music, to listen to music and to create their own music. The listening skills developed in music lessons are relevant and of great benefit to children throughout the whole curriculum, not just in music lessons. The creativity and problem solving skills children develop as they make their own musical compositions are vital to creating a well-rounded child able to perform confidently in the 21st century [1]. In the last decade, the use of information and communication technologies (ICT) in schools is commonplace and, for many teachers, an unquestionable part of everyday teaching and learning. In the case of music education, ICT-based education means (e.g., music performing software, computer-based music lessons, multimedia, etc) have been proposed, providing new ways of access, opening up new musical experiences and even enhancing teaching, in general [2].

Although sound is the aural information carrier, the auditory processing capabilities of children have often been neglected and not considered within a pedagogical framework, despite the possible effect of auditory processing disorders (APDs) in pupils' music appreciation and learning. APD is a complex problem affecting about 5% of school-aged children. These kids cannot process the information they hear in the same way as others because their ears and brain do not fully coordinate. Something adversely affects the way the brain recognizes and interprets sounds. Children with APD present deficiency in sound localization-lateralization, auditory discrimination, auditory pattern recognition, temporal aspects of audition, difficulty with competing signals and/or difficulty with degraded acoustic signals [3]. It is often hard to find an etiological basis for APD in a particular deficit; some etiologies include neurological compromise, cognitive deficit, language [4] or auditory deprivation [5]. The American Academy of Audiology consensus document [6] describes comorbid disorders in APD and proposes differential diagnosis of APD.

In the view of the above, some educational implications that derive from the results of an APD test-case in the primary school are presented and discussed here.

2. Material & Methods

One hundred children [25 (9 yrs; 11 boys; 14 girls), 25 (10 yrs; 11 boys; 14 girls), 25 (11 yrs; 14 boys; 11

DURATION PATTERN SEQUENCE (DPS)

SCORING FORM

Name:________________ Age______ Sex_____ Date:____________ #__________

PRACTICE ITEMS

PATTERN	CORRECT (x)	PATTERN	CORRECT (x)
1. LSS	___	6. LSL	___
2. SLS	___	7. SLS	___
3. SSL	___	8. LLS	___
4. LLS	___	9. LSS	___
5. SSL	___	10. SSL	___

TEST ITEMS

DURAT'N PATTERN	CORRECT	REVERSAL	DURAT'N PATTERN	CORRECT	REVERSAL	DURAT'N PATTERN	CORRECT	REVERSAL
1. SSL	___	___	21. SLS	___	___	41. LLS	___	___
2. SLL	___	___	22. LLS	___	___	42. SLL	___	___
3. LSL	___	___	23. SSL	___	___	43. SLL	___	___
4. LSS	___	___	24. SLS	___	___	44. LSL	___	___
5. LSS	___	___	25. SSL	___	___	45. SLS	___	___
6. LLS	___	___	26. SLS	___	___	46. LSS	___	___
7. LLS	___	___	27. SLS	___	___	47. LLS	___	___
8. SLS	___	___	28. LSL	___	___	48. SLL	___	___
9. SSL	___	___	29. LSS	___	___	49. SLL	___	___
10. LSS	___	___	30. SSL	___	___	50. LSL	___	___
11. SLL	___	___	31. LLS	___	___	51. SSL	___	___
12. LSL	___	___	32. LLS	___	___	52. SLL	___	___
13. SSL	___	___	33. SSL	___	___	53. LLS	___	___
14. SSL	___	___	34. LSL	___	___	54. LSL	___	___
15. SLS	___	___	35. LSS	___	___	55. LSL	___	___
16. LSL	___	___	36. SLS	___	___	56. SLL	___	___
17. LSS	___	___	37. SLS	___	___	57. SLL	___	___
18. LLS	___	___	38. SLL	___	___	58. LSS	___	___
19. SLS	___	___	39. SSL	___	___	59. LSS	___	___
20. LLS	___	___	40. LSS	___	___	60. LSL	___	___

RESULTS

	Right ear	Left ear
Percent correct	______	______
Percent reversals	+ ______	+ ______
Total Score	________	________

AUDITEC™ St. Louis, Missouri

Figure 1. The scoring form by *AUDITEC™* used in the study. *L* and *S* denote short and long duration, respectively.

girls), 25 (12 yrs; 13 boys; 12 girls)] from three public primary schools in Thessaloniki, Greece, were involved in an APD test-case study. A duration pattern sequence (DPS) test, i.e., a 3-tone sequence of short (*s*) and long (*l*) tones, combined with stereo [left (L)-right (R)] testing was performed, using the *AUDITEC™* auditory test recordings and DPS protocol (www.auditec.com). Pupils were initially familiarized with the stimuli by performing a practice phase of 10 various 3-tone patterns (5L/5R). Then, a series of 40 3-tone patterns (e.g., *ssl*;

sll; *lsl*; *lss*, etc, 20L/20R) was performed. All stimuli were presented at an average level of 70 dB SPL at the frequency of 1000 Hz. The *s* sound was 250 msec whereas the *l* one was 500 msec. The inter-tonal interval was set to 3000 msec and the rise and fall times both to 10 msec. The percentage of correctly or reversal (i.e., *s* instead of *l* or mirroring, e.g., *sll* instead of *lls*) identified stimuli formed the scores. Data analysis was performed using Matlab 7.4 (The Mathworks, Inc., USA). Figure 1 illustrates the scoring form used in the study.

3. APD Test-case Results

All the variables were found to follow non-Gaussian distribution (tested with the Kolmogorov-Smirnov test with Lilliefors significance correction); hence percentiles instead of means and standard deviations were used. Medians and percentile range per pupils' grade are presented in Fig 2. The latter denotes that age affects pupils' auditory processing, as variation in auditory scores is noticed for the transition from 9 to 12 years.

Furthermore, the statistically significant decrease (Kruskall Wallis nonparametric test) of the R/(L+R) scores for the age of 11 yrs (5th grade) it is noteworthy. Moreover, the reversal score is kept low and almost constant for all the stimuli. DPS differences between R and L ears were not statistically significant.

Finally, a significant correlation value (Spearman 0.59; p<0.01) was found between the R and L scores for pupils of 10 yrs.

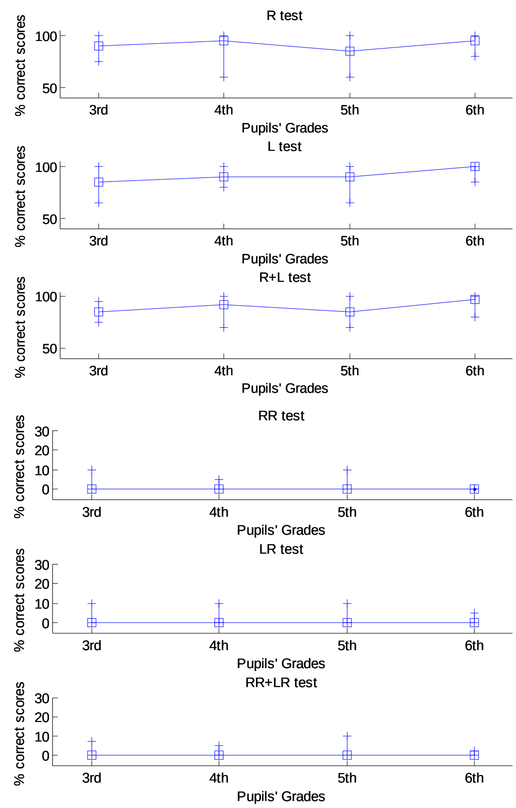


Figure 2. Scores for different stimuli. The *R (*=R, L) corresponds to reversal score for each case. Bars indicate the range between percentiles 10 and 90, whereas the middle line connects the grades medians.

4. Educational implications

4.1 Rhythm structure perception

From the above DPS test results it is clear that APD could be related with one of the basic characteristics of music, i.e., rhythm. Rhythmic motives (cells) could clearly be seen as musical metaphors of the 3-tone patterns. Consequently, based on the age effect in the audio processing, specific caution could be placed in the manipulation of musical examples for different grades, containing rhythmic cells that form more complex patterns.

Based upon the aforementioned perspective, some insight in the Greek primary school music curriculum took place, in an effort to identify any possible occurrences of such rhythmical cells in the educational practice. This is of special importance, as the books for the Greek primary school music education are newly introduced, covering just only one year in classroom practice. Consequently, their correlation to APD is totally a new concept for the Greek music education reality.

4.1.1 Third and fourth grades. For these grades, there is a common book in the Greek music curriculum. In that book, the first notion about rhythm is given to the pupils in a graphical way (see Fig. 3). In that graph, the focus is on the periodicity of the rhythm, trying to establish a kind of rhythm reference. Nevertheless, the randomness in the right graph of Fig. 3 could also provoke some rhythm patterns, yet more complex.

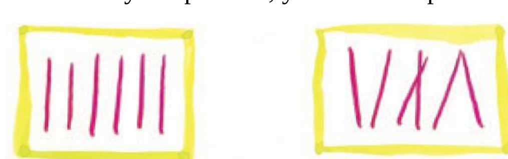
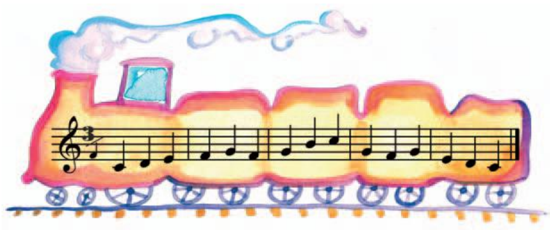
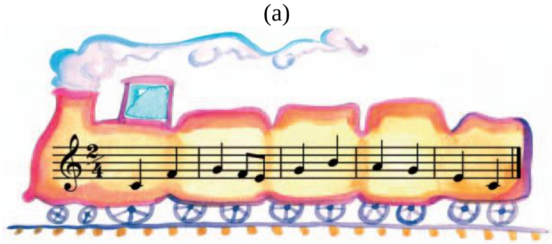


Figure 3. Graphical representation of rhythm. Left: periodic rhythm, right: absence of rhythm.



(a)



(b)

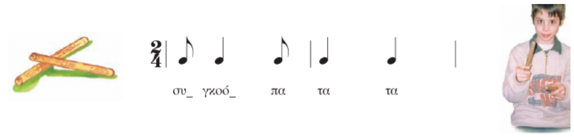
Figure 4. (a) The *lll* pattern within a melody in ¾ time signature (*l* corresponds to quarter), (b) Combination of the *lss* (bar 2) within the 2/4 time signature (*l* corresponds to quarter, *s* corresponds to eighth).

In a more advanced approach, a sequence of similar patterns is introduced (see Fig. 4(a)), where in a ¾ time signature the pattern of *lll* (where each *l* corresponds to quarter) is dominant. Moreover, the *lss* pattern (see Fig. 4(b), bar2) is combined with 2/4 time signature (*l* corresponds to quarter; *s* corresponds to eighth).

Unfortunately, rhythm analysis of the book did not reveal any complex rhythms referring to rhythmic motives, indicating a severe lack of rhythmical patterns, as the combinatory ones used in the APD test.

4.1.2 Fifth grade. In this curriculum, rhythm continues to be quite simple, indicating a lack of combinatory elements and extension of rhythmic motives. Some examples of the use of *sls* motive are shown in Fig. 5(a), along with equivalent representation of a quarter with the *lss*, *ssl* and *lll* patterns (see Fig. 5(b)). Rhythmic combination is met only at the end of the book, where the Greek anthem and some, mainly, traditional melodies serve as examples of rhythm development.

4.1.3 Sixth grade. In this grade, the curriculum tries to establish combinations of rhythm patterns by employing a polyphonic approach in the rhythm structures. As it is clear from the example of Fig. 6, a rhythmical canon is structured consisting of the simple cell of *lss* in delayed repetitions across the four players. The diminished Os denote diminuendo in dynamics across the evolution of the rhythmical pattern.



(a)

(b)

Figure 5. (a) The *sls* pattern within a melody in 2/4 time signature (*l* corresponds to quarter, *s* corresponds to eighth), (b) Combinations of the *lss*, *ssl* and *lll* on the common basis of a quarter.

Figure 6. An example of a rhythmical canon based on the delayed repetition of the *lss* pattern across the four players.

As in the previous cases, the music curriculum of the sixth grade does not involve significant information about the evolution of rhythm, showing a fragmented approach in the rhythm issue.

4.2 Rhythm variation perception

The APD test results showed low values in reversal score. This indicates the efficiency of most of the children to identify subtle variations of the tones duration; hence, to recognize rhythmic variations, even in its 'primitive' form. This approach is merely seen in the curriculum of the sixth grade only, where more macroscopic rhythmical structures are used combined with the text structure (e.g., intonation) of traditional folksongs. Such example is depicted in Fig. 7, where the variation in 3-tone cells is evident, e.g., initial appearance as quarter followed by two halves (bars 2-3, *sll* pattern with *s* and *l* corresponding to quarter and halves, respectively) and then in a complementary form (bars 3-4, *lss* pattern with *l* and *s* corresponding to half and quarters, respectively). Moreover, the *lll* pattern in

Figure 7. An example of variation of 3-tone rhythmic cells, following the structure of the text.

bar 25 is followed by the *ssl* pattern (end of bar 26), and the *ssl* pattern (end of bar 28) is followed by the *lss* one (bar 29), employing diminution of halves to quarters (*l*) and quarters to eighths (*s*).

In all cases, however, there is no conscious implementation of the rhythm variation in music lessons, but only incidental occurrence, which denotes that children mostly rely on their natural ability to distinguish rhythm changes and variations, mainly in a short time window.

4.3 Spatial perception

The equal sensitivity of pupils in L/R seen in the results facilitates the recognition of spatial music gestures (e.g., panning, surround, etc), whereas, the age of 10 yrs seems to be more effective to appreciate spatial changes. However, there is no mentioning of the spatial property of the sound in the primary music curriculum, eliminating the opportunity from the kids to imagine spatial movements and gestures, source directions, sound effects (such as delays, reflections, echo, etc) and employ them in their sound perception and gaming practice.

5. ICT implications & concluding remarks

The abovementioned observations could be reflected in ICT-based music applications. In particular, computer-based ear training could incorporate DPS-type test, providing APD quantitative results and improvement indicators to the educators in an objective fashion. Computer music games, which combine playing with music learning, could initiate and sustain targeted auditory processes (e.g., rhythm/melody/lyrics comprehension) during the game. An example of such approach is given in Fig. 8, which previews screenshots from the music education software Music Ace 2

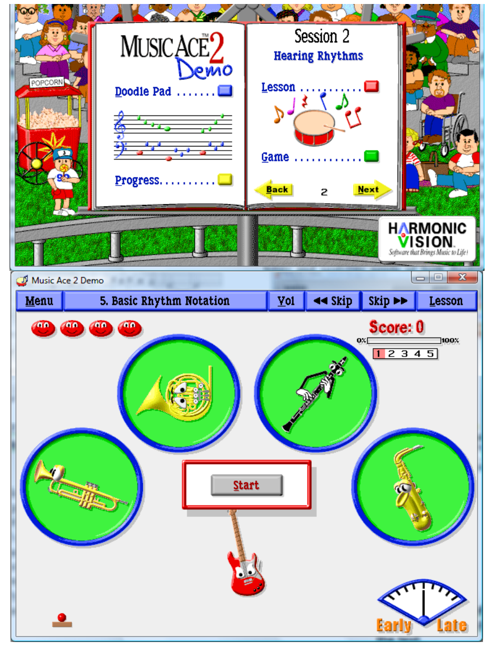


Figure 8. An example of the hearing rhythm game of the Music Ace 2 software.

(www.harmonicvision.com). This software incorporates graphic interface suited to children with a helping companion (like tutor) that helps the navigation across the functionality of the software and provides appropriate rewarding feedback. Moreover, the software combines lessons and games on basic topics of music, such as rhythm, pitch, timbre, etc.

In all cases, ICT embedded in the primary music education could support a customization to the accessibility and usability needs of both disabled and non-disabled pupils.

6. References

[1] D. Russel-Bowie, “Challenges for Primary Music Educators”, *Australian Association for Research in Education*, 28/11-2/12/2004, Melbourne, http://www.aare.edu.au/04pap/rus04727.pdf

[2] J. Savage, “Reconstructing Music Education through ICT”, *Research in Education*, vol. 78, 2007, pp. 65-77.

[3] ASHA, “Central auditory processing: current research and implications for clinical practice”, *Am. J of Audiol*, vol. 5, no. 2, 1996, pp. 41-54.

[4] J. A. Baran, “Audiologic evaluation and management of adults with auditory processing disorders”, Seminars in Speech and Language, vol. 17, no. 3, 1996, pp. 233-244.

[5] A. F. M. Snik, B. Teunissen, and C. W. R. J. Cremers, “Speech recognition in patients after successful surgery for unilateral congenital ear anomalies,” *Laryngoscope*, vol. 104, pt. 1, 1994, pp. 1029-1034.

[6] J. Jerger and F. Musiek, “Report of the Consensus Conference in the diagnosis of auditory processing disorders in school-aged children. *J of American Academy of Audiology*, vol. 11, no. 9, 2000, pp 467-474.

“SEE and SEE”: An Educational Tool for Hard of Hearing Children

Panagiotis Petrantonakis[1], Vasiliki Kosmidou[1], Magda Nikolaraizi[2], Sofia Koutsogiorgou[2], and Leontios J. Hadjileontiadis[1]
[1]*Dept. of Electrical & Computer Eng., Aristotle Univ. of Thessaloniki, GR 54124 Thessaloniki, Greece, {ppetrant, vkosm, leontios}@auth.gr*
[2]*Dept. of Special Education, University of Thessaly, GR 38221 Volos, Greece, mnikolar@uth.gr, koutsogiorgou@gmail.com*

Abstract

An educational software, namely “SEE and SEE”, that aims to enhance literacy skills of deaf or hard of hearing children is presented in this paper. The proposed computer-based educational environment, takes into account children’s visual learning characteristics. The software provides a series of adjustable functionalities to the teacher, so s/he can create visual-kinetic educational information for each pupil. Moreover, pupils have the opportunity to use bilateral presentations of the information content, by evoking sign language video for each text sentence, accompanied with comprehensive diagrams and pictures. A series of test-questions are also incorporated that reflect the contribution of each educational process to the learning curve. The whole activity is logged and archived at a local database that outputs statistic/activity reports and files. “SEE and SEE” can prove to be a useful learning object that contributes to the normalization of the educational environment towards the children needs.

1. Introduction

Deaf children face various difficulties in the development of reading skills, which are associated mostly with their poor language experiences when they arrive at school [1], [2].

Contrary to hearing children, deaf children have a limited access to language from the very first moment of their birth; hence, communication with their environment, even within the family, is merely achieved and after significant effort [3].

When deaf children have a rich language background in sign language, they are required to learn to read in another language, which is very demanding, partly because deaf children learn to read and in parallel learn a second language [1] and also because the transition from signing to the written form of an unknown spoken language is a more complicated procedure [4], [5].

So far, a series of efforts have been made in order to adapt the education curriculum to the language needs of deaf or hard of hearing children [6], [7].

In this project, a new educational software, namely “SEE and SEE”, is presented that enriches reading school texts with visual information with an aim to enhance reading comprehension levels of deaf and hard of hearing readers.

2. Structural characteristics

“SEE and SEE” consists of separate modules that are integrated on a common basis, i.e., to involve deaf kids and educators in an efficient educational environment (see Fig. 1).

The first module refers to the teacher, who could modulate the educational environment according to her/his selections. In particular, using the pallet tool, the teacher is capable of creating the relevant body text, either by uploading and/or creating her/his own text, and associating with it either video (of sign language or context-based) and/or pictures and/or diagrams.

The text editing/deletion options, provides her/him with the opportunity to modify even existing body texts, making them more adaptable to children’s knowledge skills. Moreover, a series of outputted reports are

The project is implemented by the University of Thessaly and co-financed by the European Social Fund (ESF) and national resources (Ministry of National Education and Religious Affairs-Operational Programme for Education and Initial Vocational Training).

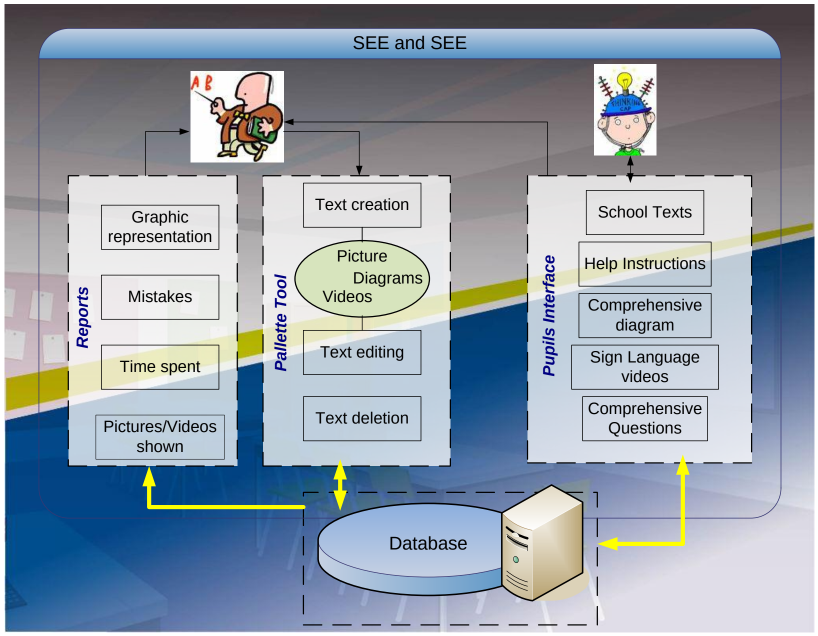


Figure 1. Structural block-diagram of "SEE and SEE". The separate interfaces for the teacher (left) and the pupil (right) are connected to a common database (bottom).

produced by the software, reflecting children's activity, i.e., software interaction, mistakes (associated with each separate event) and distribution of events across a timeline, both as graphics and as files compatible with SPSS and MS Excel software for statistic analysis. The second module is the pupil's interface (see next section), which consists of a series of available body texts (drawn from the Greek education curriculum for deaf children), and a video player, accompanied by operational buttons. Using the latter, the pupil has the capability of selecting help instructions; see a comprehensive diagram or pictures (related with the content of the current sentence); evoke the video that translates the current (highlighted) sentence (or paragraph or the whole text) to Greek sign language (GSL); respond to comprehensive questions. The total activity is archived in a local database (see Fig. 1) that is used as the bed-set for outputting the statistical reports (files). This gives the opportunity to the teacher, to evaluate each component of the educational process and proceed to appropriate modifications and customizations, according to the comprehensive level of her/his pupils. In this way, "SEE and SEE" acts as a dynamic educational tool.

3. User's scenarios

The user of "SEE and SEE" could follow the structural paths of the software (summarized in Fig. 1), previewed as a step-sequence in Fig. 2.

The user is initially prompted to the introductory page of the software (see Fig. 3(a)). By entering the system, a login page is evoked, where the user can enter into the system either as a pupil or a teacher, using an appropriate username and password (see Fig. 3(b)). The user can identify his/her self as a preexisting or a new user; in the latter case, appropriate information is inputted into the system using the corresponding menu (see Fig. 3(c)).

Logged as a pupil, s/he can select, with the guidance of the teacher, a text from a variety of prepared enhanced texts, according to the curriculum corresponding to her/his age and comprehension ability. This evokes the central pupil's page (see Fig. 4(a)), where a main window presents the text to the pupil in the form of sentences and paragraphs. By selecting a sentence with a mouse-click, a video translating the sentence in Greek sign language is previewed in the video-window above the text-window (see Fig. 4(a)), and the sentence corresponding to the video is highlighted, indicating the synchronization between the current text and video. The video-window has a media-player like functioning, i.e., play, stop, pause; hence, the pupil could navigate through the video according to her/his needs. In the default texts, all sentences are linked to Greek sign language videos; in some cases, however, the teacher could link selected text only either with Greek sign language videos or some additional videos related to the general content. In both cases, the pupil could see

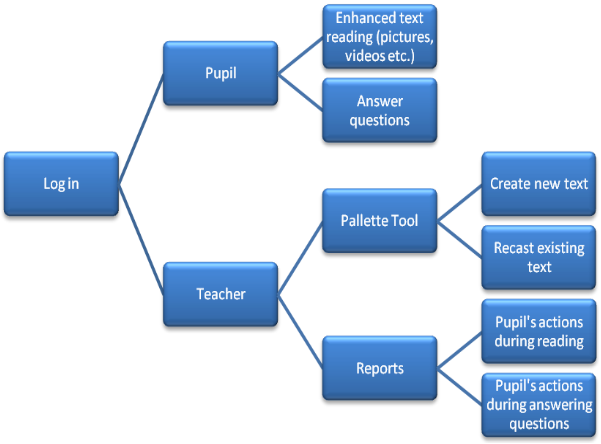


Figure 2. Step-sequence of "SEE and SEE" functionality, according to its structural characteristics illustrated in Fig. 1.

which sentences are hyperlinked with video and which are not during her/his interaction with the software.

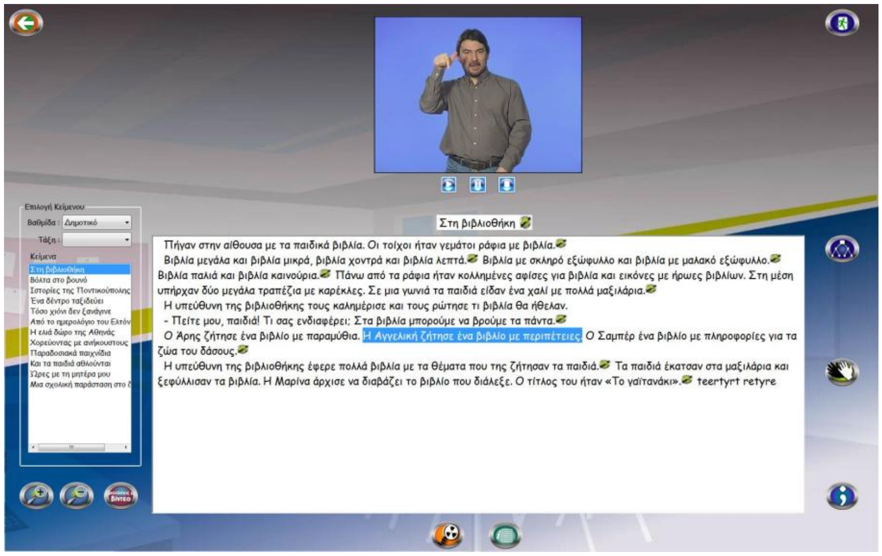
In many cases, at the end of a sentence a hyperlinked icon exists that, when clicked, evokes a drawing previewed at the video-window area, which relates to the content of the corresponding sentence or paragraph in a descriptive way. Zoom in/out facilities are available both for text- and drawing-windows.

A diagram is also available for each text, which could be evoked at any time during the educational process and can be used as a content-map that could serve as a comprehension scaffolding tool. In addition, the whole text is linked with a video which plays the whole text from the beginning throughout the end, helping the pupil to unify the meanings of the separate sentences and paragraphs of the text and realize its overall content. In all cases, help is available, either in Greek sign language video or as a text.

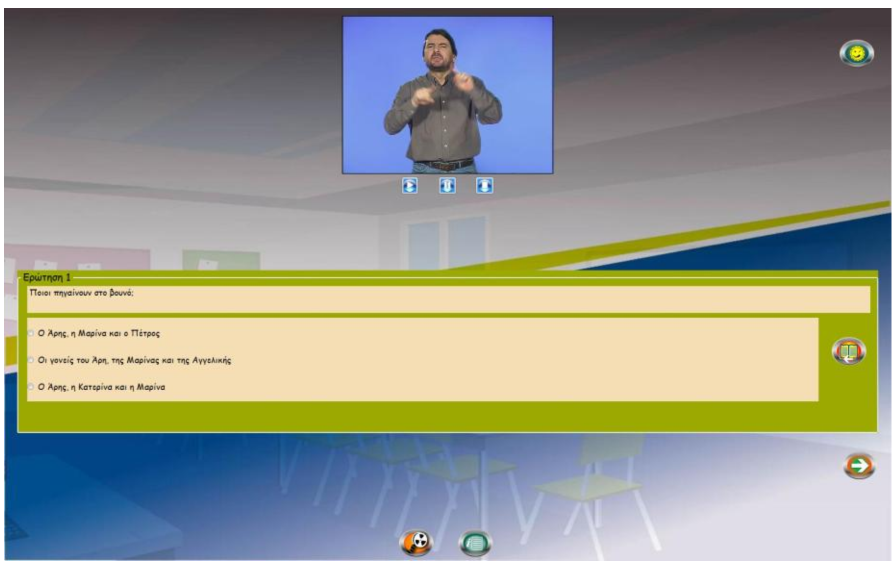
By pressing the Greek question mark button (see Fig. 4(a)), the pupil is prompted to a new window that includes a series of comprehension questions (see Fig. 4(b)). The video-window is preserved in this form and it is activated when the pupil left-clicks on the text, evoking the corresponding Greek sign language video. The pupil selects from multiple-choice type available answers and gets a reflection message if her/his answer

Figure 3. (a) The introductory page of the "SEE and SEE" software, (b) the login page where the user can enter as a student or a teacher using a username and password, (c) the insertion of a new user menu (here a student of First Grade is created).

is correct or not. Moreover, at any time s/he can return back to the text to draw more conclusions upon her/his answer selection.



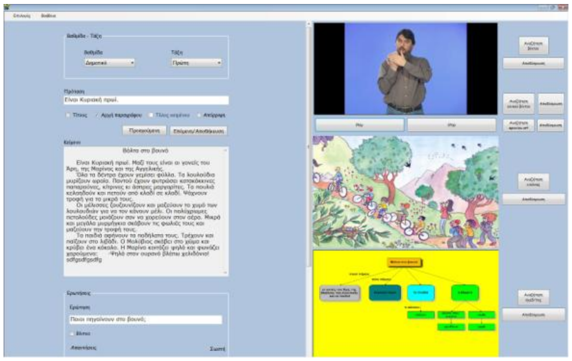
(a)



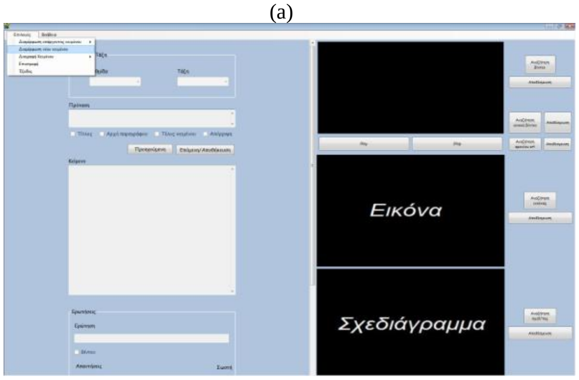
(b)

Figure 4. (a) The central pupil's page with text- video- and selection-windows, along with selection buttons (help, zoom in/out previewing, drawings, diagram, video for the whole text) and link buttons (back, exit, questions), (b) The question-page which includes multiple-choice type questions with links to Greek sign language video and return to text-window for assisting pupil's comprehension and respond.

From the teacher's perspective, when s/he logs into the software, s/he can select either to use the pallet tool or to preview some reports (see Fig. 2). In the first choice, s/he can edit a preexisting session (see Fig. 5(a)) by modifying the text and the linked material (e.g., video, drawings, diagrams etc), whereas in the second one, s/he can create a whole new session, by adding new text and new linked material (see Fig. 5(b)). Finally, the teacher can preview a series of statistics and reports regarding to the interaction of the pupil with the software, as in all cases, pupils' clicks are logged into the system. The previewing of the statistics is implemented with barline-plot (see Fig. 6); the teacher can select the statistics of individual and/or grouped interactions by selecting the appropriate check-boxes.



(a)



(b)

Figure 5. The pallet tool of the “SEE and SEE” software for (a) editing preexisting session or (b) creating a new one.

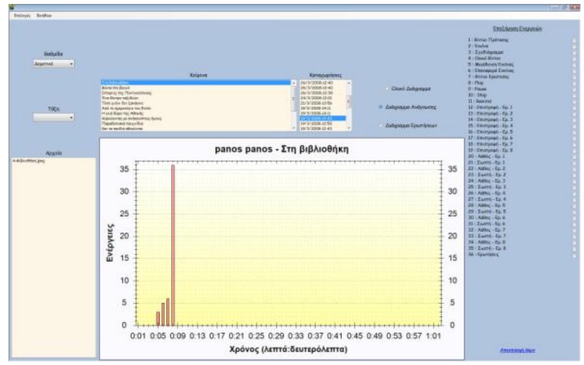
4. Concluding remarks

The bilateral preview of the language information within the “SEE and SEE”, i.e., in Greek and in GSL, covers the whole spectrum of deaf or hearing impaired children, communicating either in Greek or in GSL, as the visual information is processed and evaluated according to each pupil’s needs. As vision is important aspect in acquiring and understanding information for these kids [8], the visual-kinetics aspects of “SEE and SEE” contribute towards comprehension enhancement.

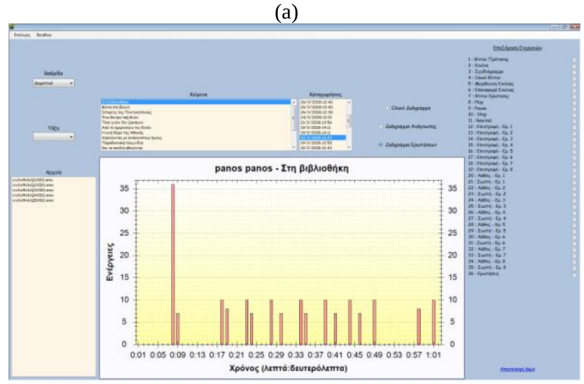
Moreover, this type of software could initiate and motivate the educators to reflect upon their educational strategies within the classroom and, in turn, expand them in a way that could reform the current curriculum and increase pupils’ social inclusion and assist their profession capabilities [7].

5. References

[1] C. Perfetti and R. Sandak, “Reading optimally builds on spoken language: Implications for deaf readers”, *Journal of Deaf Studies and Deaf Education*, vol. 5, 2000, 32-50.



(a)



(b)

Figure 6. Example of the reporting page of the “SEE and SEE” software for monitoring pupil’s interactions during (a) reading comprehension, (b) answering the questions.

[2] J. Andrews and J. Mason, “Strategy usage among deaf and hearing readers”, *Exceptional Children*, vol. 57, 1991, pp. 536-545.
[3] Gregory, S. *Deaf children and their families*. Cambridge, U.K.: Cambridge University Press, 1995.
[4] S. Goldin-Meadow and R. Mayberry, “How do profoundly deaf children learn to read?”, *Learning Disabilities Research and Practice*, vol. 16, 2001, pp. 222-229.
[5] Nikolaraizi, M. and Drevelega, E. “The reading development of deaf children: exploring teachers’ views” in V. Lampropoulou (Ed.), *Proceedings of International Conference “Inclusion of the deaf in the Education and Society*”, Patras, The University of Patras, 2003, pp. 135-143.
[6] Marshark, M., Lang, H, and Albertini, J. *Educating deaf students: From research to practice*. Oxford: Oxford University Press, 2002.
[7] C. Musselman, “How do children who can’t hear learn to read an alphabetic script? A review of the literature on reading and deafness”, *Journal of Deaf Studies and Deaf Education*, vol. 5, 2000, pp. 9-31.
[8] J. Luckner, S. Bowen, and K. Carter, “Visual teaching strategies for students who are deaf or hard of hearing”, *Teaching Exceptional Children*, vol. 33, 2001, pp. 38-44.

Encouraging Persons with Hearing Problem to Learn Sign Language by Internet Websites

Mohammad Shirali-Shahreza
Computer Science Department
Sharif University of Technology
Tehran, IRAN
shirali@cs.sharif.edu

Sajad Shirali-Shahreza
Computer Engineering Department
Sharif University of Technology
Tehran, IRAN
shirali@ce.sharif.edu

Abstract

Nowadays the Internet users are from different ages and groups. Disabled people are a group of the Internet users. Some websites are especially created for these people. One group of the disabled people are deaf persons. They have a special talking language which is named sign language. Here we present a method to encourage them, esp. children, to learn the sign language. In this method, when a deaf person wants to enter a website which is created for deaf persons, a word is shown as a movie using a sign language. The user should recognize the word and select it from a list. If the user understands the sign language and recognizes the word, he/she can enter the website. This method is created based on a special HIP (Human Interactive Proofs) system which is designed for deaf persons. This project has been implemented by PHP scripting language.

Keywords: *Deaf Persons, Disabled People, E-Learning, HIP (Human Interactive Proofs), Sign Language.*

1. Introduction

Internet Expansion and development of the Internet in all aspects of daily life have been one of the great successes in recent years. One of the applications of the Internet is using it in learning and establishing e-learning systems.

Because of the growth of the Internet and the easy access to it, a great deal of private and personal information is available on the web.

On the other hands, nowadays the Internet in not only for special groups of people, but also people from any age and different groups are using the Internet. There are many websites for children on the Internet and the children using the Internet for various activities such as entertaining, educating, etc. The elderly people communicate and chat with their children and relative using the Internet.

One important group of Internet users is people with disability. Some of the Internet websites are especially developed for disabled persons. Some of these websites are designed for learning to disabled people.

One group of the disabled people are deaf persons. Deaf persons have a special talking language. They are using sign language which uses manual communication, body language and lip patterns instead of sound to convey meaning—simultaneously combining hand shapes, orientation and movement of the hands, arms or body, and facial expressions to express fluidly a speaker's thoughts.

Deaf persons should learn sign language as soon as possible to able to communicate with other peoples.

Here we present a method to encourage deaf persons, esp. children, to learn the sign language. For this purpose we use our invented method [1]. The used method is a kind of HIP methods.

HIP is abbreviation of Human Interactive Proofs and is applied to call systems in which human user proves their membership in a special group through a challenge/response protocol. Some examples are: human versus machine, user himself versus any other person, adult human versus a child, etc [2].

HIP methods are mostly used to tell human and machine apart and are called CAPTCHA (Completely Automatic Public Turing Test to Tell Computer and Human Apart). In the next section, we will discuss these methods in more details, but little work has been done in the field of telling users groups apart.

In our method, when a user wants to enter a website which is created for deaf persons, a word is shown to the user using sign language through a movie and he/she is asked to select the shown word from the list. In the third section, details of our method and its implementation will be mentioned.

In the final section, the conclusion will be made after investigating and studying some advantages of this method.

2. CAPTCHA methods

As mentioned before, most of the earlier projects in field of HIP is related to telling human and machine apart and referred to as CAPTCHA. In this section we study and examine CAPTCHA methods and its usages briefly.

CAPTCHA are systems which are used to distinguish between human and machine automatically. These systems are based on Artificial Intelligence (AI) topics. They are similar to Turing test [3], but they differ in that the judge is a computer [4]. The goal of these systems is to ask questions which human users can easily answer, while current computers cannot.

CAPTCHA methods can be generally divided into two groups: OCR-based and Non-OCR-Based.

In OCR-based methods, the image of a word is shown to user with distortion and various pictorial effects and he must type that word. Due to presence of various pictorial effects, the computer will encounter problems in the recognition of these words and only human user will be able to recognize the word. Examples of these methods include Gimpy [4] and Persian/Arabic Baffle Text [5]. But these methods usually result in dissatisfaction of users. On the other hand, efforts have been made for attacking these methods [6].

However, these methods usually disturb the users, therefore Non-OCR-based methods in which they do not use OCR systems have been presented so far. Examples of these methods include Collage CAPTCHA [7], PIX [8], and Text-to-Speech [9].

For example, in Collage CAPTCHA the images of some different objects (for example six objects such as airplane, car, apple, orange, pineapple and ball) are chosen. Then some effects such as rotating are done on the images and they are merged to create a single image. This image is shown to the user and he/she is asked to click on a certain image (for example on the image of the car) (Fig. 1).

The Non-OCR-Based methods are easier to work with than OCR-based methods and also can be used by disabled people.

The HIP method [1] which is used in this project is a Non-OCR-Based CAPTCHA method. This method will be described in the following section while explaining our proposed method.

3. Our proposed method

In this section, we explain our method which is designed for encouraging deaf persons to learn the sign language [1].

Our method is based on understanding the word which a person says using ASL (American Sign Language). In our method, a small movie is shown to the user. The movie shows a person which says a word using ASL. Then a list of words is shown to the user and he/she must choose the correct word. If the user chooses the correct answer, he/she passed the test and can continue using the website. Otherwise, a new test is generated for him/her.

Our method has been implemented by PHP programming language. In this implementation, at first a database of the movies of the words in sign language is collected. We used the movies which were created by Dr. David Stewart and his team at Michigan State University. These movies are available at the “ASL Browser” website [10]. There are more than 4500 words available in their library.

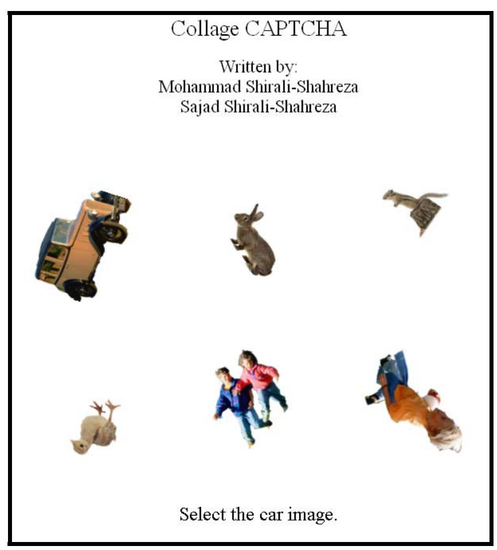


Figure 1. A sample of Collage CAPTCHA [7]

For each word, the "ASL Browser" site has a movie shows a person saying the word using ASL (American Sign Language). The movies are in Quicktime (.MOV) format. Our database uses these movies and for each movie, we store the text of the word which the person says. The movie files have good quality and can be understood easily; while they have small sizes (average size of them is about 100 KB).

To generate a test, the program chooses a random word from the database and shows the movie of that word to the user. Then it selects some other words (for example 3 other words). By showing more words, the difficulty of test is increased. Now the program shows all of these words to the user and asks him/her to select the word which is said in the movie.

When the user sends his/her answer, the program checks the answer and if the user chooses the right word, a message informs the user that he/she passed the test successfully and he/she will be allowed to enter the website. Otherwise, a message is shown to the user indicating that the answer was wrong. Then a new test is generated for him/her and shown to him/her.

A sample implementation of this project is available at: http://www.hip.ir/DeafHIP/ (Fig. 2).

In this site, 16 common words (such as "hello", "car" and "cat") are selected from the main database. The program chooses one of these words and shows the movie of this word to the user. Then the user is asked to select the shown word from a list of four words.

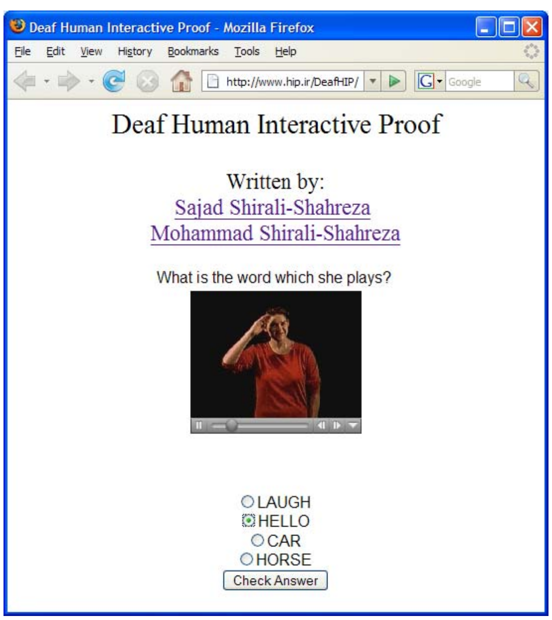


Figure 2. An screenshot of our project website [1]

Instead the above mentioned method, we can use another different method for asking a question from the user. The resources of this method are the same as above method. But in this method instead of asking the user to select the word which is shown by sign language, we select a word and show the movie of this word to the user along with the three movies of the other words. The user is asked select the select the movie of the asked word from a list of four shown movies.

While it seems that this method is easier for user to answer, but in this method the website loading time is high. However the download time can be reduced by lowing movie quality, convert it to grayscale, etc.

4. Conclusion

In this paper, a method is introduced for encouraging deaf persons, esp. children, to learn the sign language when using the Internet. In this method, a word is shown using sign language and the user should recognize the shown word and select its name from a list.

The difficulty of this method can be changed by changing the number of words which are shown to the user to select the correct answer from them.

This method only shows a small movie; therefore the website loading time is low. In addition, the download time can be reduced by lowing movie quality, convert it to grayscale, etc.

It does not require any processing on client side and can be used on small devices and devices with limited resources such as mobile phones. Also no keyboard is needed in this method because it only needs to select the word from a list. Therefore, it can be run on devices without a keyboard or devices in which it is difficult to use their keyboard; such as mobile phones.

This method is implemented entirely in PHP language. Because PHP is a well known open source and platform independent language, most of the web hosting companies support it, so this method can be easily integrated to available websites with low cost.

Instead of creating the database of sign language movies, we can use a text-to-sign language synthesis tool like [11] to create a movie for a word. By using this system, we don't need a large space for storing the movies. Also we can use similar tools to create cartoonish characters or convert the movies to cartoonish style (For example convert the movies to watercolor style) using special programs to attract the children.

Similar method can be created for other groups of disabled people.

5. References

[1] S. Shirali-Shahreza and M. Shirali-Shahreza, "A New Human Interactive Proofs System for Deaf Persons," *Proceedings of the 5th International Conference on Information Technology: New Generations (ITNG 2008)*, Las Vegas, Nevada, USA, April 7-9, 2008.

[2] H.S. Baird and K. Popat, "Human Interactive Proofs and Document Image Analysis," *Proceedings of the 5th IAPR International Workshop on Document Analysis Systems*, Springer LNCS 2423, pp. 507-518, 2002.

[3] A. Turing, "Computing Machinery and Intelligence", *Mind*, vol. 59, no. 236, pp. 433-460, October 1950.

[4] L. von Ahn, M. Blum, and J. Langford, "Telling Humans and Computers Apart Automatically," *Communications of the ACM*, vol. 47, no. 2, pp. 57-60, February 2004.

[5] M.H. Shirali-Shahreza and M. Shirali-Shahreza, "Persian/Arabic Baffletext CAPTCHA," *Journal of Universal Computer Science (J.UCS)*, vol. 12, no. 12, pp. 1783-1796, December 2006.

[6] K. Chellapilla K. and P. Simard, "Using Machine Learning to Break Visual Human Interaction Proofs (HIPs)," *Advances in Neural Information Processing Systems (NIPS'2004)*, MIT Press, 2004.

[7] M. Shirali-Shahreza and S. Shirali-Shahreza, "Collage CAPTCHA," *Proceedings of the 20th IEEE International Symposium Signal Processing and Application (ISSPA 2007)*, 2007.

[8] M. Blum et al, *The CAPTCHA Project (Completely Automatic Public Turing Test to tell Computers and Humans Apart)*, School of Computer Science, Carnegie-Mellon University. URL: http://www.captcha.net

[9] T.Y. Chan, "Using a text-to-speech synthesizer to generate a reverse Turing test," *Proceedings of the 15th IEEE International Conference on Tools with Artificial Intelligence (ICTAI 2003)*, pp. 226-232, 2003.

[10] D. Stewart et al., *American Sign Language (ASL) Browser*, Michigan State University, May 2007.
URL: http://commtechlab.msu.edu/sites/aslweb/

[11] M. Papadogiorgaki, N. Grammalidis, D. Tzovaras, and M.G. Strintzis: "Text-To-Sign Language Synthesis Tool," *Proceedings of the 13th European Signal Processing Conference*, Antalya, Turkey, September 2005.

Accessibility and Usability of Virtual Learning Environments

Marion Hersh
Department of Electronics and Electrical Engineering, University of Glasgow
m.hersh@elec.gla.ac.uk

Abstract

The paper commences with a discussion of some of the factors to be taken into account in making VLEs fully accessible and usable by all disabled and non-disabled students and staff. This discussion is followed by a report and commentary on the results of two short surveys of disabled and non-disabled users of VLEs and institutional practice in higher and further education respectively.

The results of the survey of individuals showed the need for text-to-speech conversion software in a range of languages and for mathematics, figures and tables and the lack of user knowledge of the accessibility features of VLEs. The survey of institutions indicated that VLE use is widespread and possibly universal in colleges and universities in the UK and that accessibility considerations have affected the choice of VLE in many institutions, but generally not been one of the main factors. In addition, many colleges and universities provide information on their websites and/or training on accessibility issues, but there is some concern about implementation of accessibility policies by teachers and lecturers.

1. Introduction

On-line learning is becoming increasingly popular and virtual learning environments (VLEs), content management (CMS) or learning management systems (LMS) are used to support and administer the process. Although the terms are sometimes used interchangeably, CMS were originally designed for academic environments, whereas LMS were intended for workplace learning environments. The different types of learning requiring support have led to LMS being oriented to registration and administration functions and CMS supporting longer term ongoing classroom courses, though more recent CMS also provide many administrative features [2]. There are at least a hundred different VLEs [7], of which more than 50 use only open source software [9].

1.1. Accessibility and usability

There has been a tendency to focus on the accessibility, rather than usability of technology for disabled people, though both are essential and complementary and should be considered part of good design practice. Accessibility relates to the environmental characteristics of the system input and output which enable particular (groups of) users to use the system, whereas usability is the ability of the system to carry out the intended function(s) or achieve specified goals effectively, efficiently and with satisfaction when used by particular (groups of) users in their particular context [5, 8].

There are disabled people in all parts of the world. Therefore, there is a need for accessible e-learning platforms with supporting documentation in multiple (including non-European) languages, which can be used in a wide range of different cultural contexts and which perform well with low bandwidth connectivity [1].

2. Accessibility of VLEs

Accessibility and usability of a VLE are multi-dimensional and should cover at least the following features for the full range of disabled learners and teachers, using a wide range of different assistive input and output devices:

- All student functions.
- All administrator and teacher functions, including editing and accessible content authoring, with prompts for features such as alternative text descriptions of figures.
- Navigation and links.
- The content and formatting of documents posted on the system.
- System modification in the case of open source software.

There is increasing awareness of the importance of making information accessible to blind and other disabled people and legislation in many countries which requires this. The use of VLEs potentially has the ability to make teaching content more accessible to disabled people and use of the World Wide Web Consortium (W3C) Web Content Accessibility Guidelines (WCAG1 and 2) [10, 11] could support this process. However, progress in practice has been relatively slow and accessibility and usability still do not feature high on the list of essential features for VLEs.

Accessibility does feature in the criteria used in the evaluation of learning management software [3] forming part of the New Zealand Open Source Virtual Learning Environment Project, but does not have a high profile. While accessibility is not discussed in detail, this discussion of evaluation criteria proposes the following 'accessibility hooks':

- Full support for text-only navigation, including link shortcuts, hidden links and descriptive link texts.
- Full support for alt text descriptions for graphics and rich media.
- Scalable fonts (text) and graphics.

Currently one of the most accessible VLEs is ATutor. The accessibility features it provides include keyboard access to all system components, adaptive navigation facilities which allow users to go directly to content bypassing non-essential elements and prompts for alternative text descriptions of figures [4].

2.1. Accessible content

Graphics frequently play an important role in teaching, particularly in the sciences and engineering, by providing important supplementary or complementary information to the main text. In some cases the graphical representation may even provide the main or sole presentation of a particular section of content. Graphical material is inaccessible to many blind and visually impaired people, amongst others. Electronic versions of the material have the potential to overcome this accessibility barrier, in particular through the provision of alternative text descriptions. VLEs can encourage this, for instance through prompting for such descriptions.

However, a recent study by the author [6] of PDF accessibility found that where alternative text descriptions of figures had been included, they generally only provided the figure caption and did not actually describe the figure. Such alternative descriptions meet the technical accessibility requirements, but do not provide any useful information about the figure to users of screenreaders. Resolving this problem will require the development of recommendations and guidelines as to what constitutes good alternative text descriptions, as well as examples of good and bad practice with explanations as to why they are good or bad practice. It may also require investigation of different types of graphics and the associated learning aims to enable suggestions to be made of the different types of text description that are appropriate in each case. A related issue is the representation of mathematics.

Another important issue is the relation between type of content format, nature of the content and explanatory power. In particular, this should include the extent to which descriptions of figures provide the same type of information and are able to support learning in the same way as the figures themselves. This also raises issues of how different groups of people, particularly blind and visually impaired people, conceptualise and process information with a view to understanding and learning. Investigation of these issues will require both the development of theory and models and empirical investigations. There may also be a need for educational content authors to examine the role of graphics in their teaching material to ensure that learners have full access to this learning content, whether through the provision of alternative text descriptions or in some other way. This may also require the development of new pedagogies for the provision of accessible electronic learning materials.

3. Survey of Accessibility of VLEs

In order to investigate the accessibility of existing VLEs two surveys were carried out:

- Of universities and colleges in the UK with the aims of investigating the extent to which their VLEs were accessible and their knowledge about accessibility issues relating to VLEs.
- Of the experiences of disabled and non-disabled users of VLEs.

Both surveys were sent out by email and respondents were given the opportunity to respond by email or post. A remainder was sent out by email to all non-respondents a few days before the deadline.

3.1. Survey of disabled and non-disabled students and staff

Due to time constraints, the survey was restricted to contacts of the author working in the area of assistive technology, including both disabled and non-disabled students and staff, and it was not possible to define control groups of non-disabled staff and students. This would have involved sending the survey to the same numbers of disabled and non-disabled students and staff at each institution with the groups of disabled and non-disabled people matched on factors such as gender, race and seniority, amongst others.

Thus, the present survey can be considered as a pilot survey, which will identify issues for further investigation and may lead to modification of the questionnaire before it is used in a large scale controlled survey, as described above.

The questionnaire commenced with a few personal questions, including on the respondent's impairments and their use of assistive technology, for statistical analysis and correlation purposes. The questions in the main part of the questionnaire covered the following topics:

- Whether their programme of study, department or school uses a VLE and, if so, which one.
- How easy this VLE is to use.
- Whether this VLE has any features to make it easier for disabled students and staff to use and, if so, which ones and whether the respondent personally finds these features useful.
- How accessible they personally find this VLE.

Respondents were given the opportunity to provide comments after each multiple choice question as well as to provide general comments and further information at the end of the questionnaire.

3.2. Survey of universities and colleges

The survey was sent to the 129 members of Universities UK, which includes a few further education colleges as well as universities, and to 120 different colleges, chosen at random from a web-based list of all the UK colleges. Where appropriate addresses could be found, the questionnaire was sent to a named person in the IT or Computer Services Department. Otherwise it was sent to the help desk or webmaster. Where these addresses could not be obtained, the questionnaire was sent to the Student Disability Service. Since it was rarely possible to find contact emails for specific named people or people in particular departments on college web sites, most of the college questionnaires were sent to the webmaster and/or the general enquiries address.

Colleges and universities were asked the following questions:

- Whether the institution uses a particular VLE and, if so, which one.
- What were the main reasons for the choice of this VLE and whether accessibility to disabled students and staff influenced the decision.
- Whether the VLE provides any particular accessibility features and brief details of these features, if any.
- Whether the institution provides guidelines and recommendations and/or training on making documents accessible (and usable) and brief details (or provision of materials) of any guidelines, recommendations or training.
- Whether the institution provides guidelines and recommendations and/or training on making documents provided on the VLE accessible and brief details (or provision of materials) of any guidelines, recommendations or training.

Thus, this very brief questionnaire asked for a mixture for quantitative and qualitative data and provided considerable opportunities for institutions to comment and supplement their answers.

4. Results

4.1. Disabled and non-disabled staff and students

Replies were received from five women and four men, of whom three were members of staff and three students in higher education institutions (HEI), one a member of staff in a further education institution, one in industry with a secondary career as a member of staff in an HEI and one a member of staff in a secondary school. One HEI member of staff and one student had secondary careers as an HEI student and member of staff respectively. One of the respondents was blind and used assistive technology (AT) and the other eight were non-disabled and did not use AT.

The programmes of study, departments or schools of six respondents used VLEs, one did not, and one respondent was unsure. The VLEs used included AVOIR, Moodle and Scenaria. One respondent found the VLE very easy and one easy to use and two neither easy nor difficult. Three were unsure. One of the respondents had used an early version, which they found cumbersome and seems to have been discouraged from trying later versions for this reason. Another respondent commented that their VLE was easy to use, but difficult to code, as it was missing important functions such as user management, which would, however, be included in a later version.

One respondent thought the VLE had features to make it easier to use by disabled students and staff, one thought it did not and four were unsure. The only feature mentioned was learning materials written in very large characters for visually impaired people. It is not clear whether this refers to the facility to personalise the font size or particular documents. A respondent commented that the current version had little support for blind users, though there were promises to provide it. One respondent found the VLE accessible as a whole and one partially accessible, whereas five were unsure. One respondent 'hated' the user management system and found that expanding the system with new features or developing new modules was not 'very clean'. Another was able to use Moodle in learning, but had problems in creating virtual simulations and three dimensional virtual environments. A respondent suggested that VLEs had a lot of potential benefits in education for disabled students, but even non-disabled students did not know a lot about them. Another had found the HTML pages generated by Moodle a few years ago partly accessible, but had not tried it recently. A third respondent would like more text-to-speech conversion software in Romanian, as well as text-to-speech conversion software for texts including figures, tables and formulae.

4.2. Universities and colleges

Replies were received from 18 universities and eight colleges, all of which used a VLE. In most cases there was an institutional standard VLE which was generally used. Most institutions used either Moodle or Blackboard, with the colleges having a strong preference for Moodle (six colleges), whereas the universities had a strong preference for Blackboard (12 universities, with three using Moodle and one about to adopt it). One of the universities had adopted a VLE before Moodle was available. Two universities, but no colleges are using other systems. One of them is using Student Portal and 'Emily' and the other currently has a home made virtual learning portal and is in the process of deploying Desire2Learn. One of the institutions using Moodle is in the process of transferring to Sakai.

Five of the universities using Blackboard specified which version of the Campus Suite they are using (between 4 and 7) and one of those using Moodle specified that they use version 1.6. None of the colleges specified which version they use.

One of the respondents noted that 60% of further education colleges use Moodle, indicating that the preference found in this survey holds more generally across further education, though it is not quite as strong as obtained here. The main reasons for colleges' choice of Moodle were costs, the fact that it is Open Source, ease of use, functionality, including integration with existing systems, and the availability of support. The main considerations for universities were ease of use, functionality, pedagogical issues, including not constraining users to a particular pedagogical approach and support for sophisticated course design, and the availability of support. Cost considerations seemed to have been less important than for colleges, with only two universities mentioning costs. Only one of the universities using Moodle mentioned the importance of Open Source. Therefore many of the main reasons for choice of a particular VLE are common to both colleges and universities, but costs played in greater role in the college choices and pedagogical issues in the university choices. One college mentioned ease of use with screenreaders and two university mentioned accessibility as being important factors.

When asked specifically whether considerations of accessibility to disabled staff and students had influenced the choice of VLE, 11 universities and five colleges stated that it had, though in the case of one university this was limited to concern that the VLE provided some basic accessibility features. One university and two colleges had not been influenced by accessibility considerations and six universities and one college were unsure. In combination with the previous responses this indicates that about two thirds of the institutions had considered accessibility when making decisions about which VLE to adopt, but that it had been a major consideration for only a small number of them.

Three colleges and 12 universities thought that the VLE they used provided particular accessibility features, four colleges and five universities were unsure and one university believed that it did not. There is obviously a need for this latter university to either change its VLE or upgrade to a later version which does provide accessibility features. The accessibility features university respondents were aware of included compliance with accessibility standards such as those of the World Wide Web Consortium Web Content Accessibility Guidelines and legal requirements such as those of the UK Disability Discrimination Act (DDA) 1995 and Section 508 of the US legislation, though one university noted that they are not aware of any VLE that fully conforms to the DDA. Other features included the ability to customise the system with regards to layout, colour and text size, compatibility with screenreaders, the availability of high contrast colour schemes and keyboard accessibility features. One university respondent drew attention to the problems caused by teachers putting up inaccessible materials even if the VLE is itself accessible.

15 universities provide recommendations and guidelines on document accessibility and 13 of them also provide training, whereas six colleges provide recommendations, guidelines and training. Two university respondents were unsure whether their institution provides guidelines and recommendations

and three were unsure whether it provided training. One college was unsure whether it provided guidelines and recommendations. One university and two colleges do not provide training and one college does not provide guidelines and recommendations. Four colleges provide recommendations and guidelines and three training on making documents on the VLE accessible and 11 universities provide recommendations and guidelines and ten training.

One university respondent noted that their guidelines were not very prominent or widely known. It is clearly insufficient to have policies, guidelines or recommendations on accessibility unless they are made known to all members of staff and measures are taken to ensure that they are generally implemented. The issue of accessibility guidelines not being widely known is in line with anecdotal evidence that universities have quite good policies on a range of equality issues, but are less good at ensuring they are implemented and that the implementation is monitored. This is borne out by the comment from one of the universities that it is difficult to monitor whether the guidelines are followed and that their experience indicates that take-up of specific training on accessibility is generally low. One college and three universities are unsure whether they provide guidelines and recommendations. One college and two universities are unsure whether they provide training. Three college and three universities do not provide guidelines and recommendations. Four colleges and five universities do not provide training.

A number of universities and colleges provided additional information about their training. Both the approaches of integrating accessibility issues into general e-learning training and separate courses on accessibility were represented. For instance, one institution had made an explicit decision to include accessibility as part of all their e-learning training rather than to run separate accessibility training events. At least one institution combines both approaches. This has the advantage of 'mainstreaming' accessibility by integrating accessibility training with general training, while providing more in-depth or detailed training on specific accessibility topics through separate courses.

Examples of the different types of training provided include the following:

1. A brief overview of accessibility and assistive technology followed by a 50 minute hands-on session creating accessible HTML learning modules.
2. A self-paced specialist online course module on creating accessible learning material which lasts one to four hours depending on prior knowledge.
3. One-to-one sessions with the webmaster for people responsible for creating content. However, a high proportion of staff are now involved in some content creation and resource limitations will generally make it difficult to provide individual sessions for all these staff.
4. Inclusion of accessibility considerations in all training courses related to web site design.
5. Encouraging staff to access resources about accessibility and to attend a session on the use of WIMA Course Genie (now called Create) which is considered to be fully SENDA (Special Educational Needs and Disability Act 2001) compliant.

Several institutions provide information on their web sites on accessibility topics. One university provides a good practice guide to accessible curriculum design, which covers a number of topics, including assistive technology, making web pages and online coursework accessible and making online modules accessible. Another institution provides a link to the JISC TechDis documents, which cover authoring accessible documents, producing accessible PDFs and producing accessible presentations. Several universities provide information on accessible website design.

One institution had included targets for improving accessibility of all their web pages and online teaching materials in their Disability Action Plan. This plan is a requirement on all public bodies as a result of recent legislation in the UK. This institution's Disability Advisory Group advises on auditing information services materials and policies. Another institution has a communications policy for text and layout.

In general the college respondents provided less detailed information than the university respondents. Training and guidelines include the following:

1. Regularly updated Moodle training for all staff.
2. Following the guidance of JISC TechDis (the UK educational advisory service on accessibility and inclusion).
3. Training (on document accessibility), which takes place in the staff development area, initially in small groups and then on a one-to-one basis.
4. Frequent training events, which are available to all staff.
5. Regular staff training for teachers on issues relating to the DDA, though the college finds it more effective to personalise documents and materials due to the size of the institution.

However, none of the colleges provided specific information about the accessibility components of their training.

As already noted, both colleges and universities were slightly less likely to provide guidelines and recommendations or training on making VLE documents than on general document accessibility and usability. They also provided less detailed information about their provision in this case and what information was provided was generally similar to that provided in the general case.

5. Conclusions

This paper commenced with a discussion of some of the issues to be taken into account in making VLEs accessible and usable by disabled students and staff and noted that new pedagogical approaches may be required.

The paper also reported the results of two surveys. The first survey was a small scale pilot survey of disabled and non-disabled users of VLEs. It will be followed up by a large scale controlled survey of disabled and non-disabled staff and students approximately matched by characteristics in each institution surveyed. The results of the survey highlighted the need for text-to-speech conversion software for a much greater range of different languages, as well as text-to-speech conversion software specifically designed for mathematics, figures and tables. Nearly half the respondents were unsure whether their institution's VLE had features to make it easier to use by disabled staff and students (with a third not replying to this question), indicating a lack of knowledge of accessibility issues relating to VLEs. This is worrying, particularly since the respondents were working in the area of assistive technology and therefore likely, if anything, to be better informed on accessibility features than average VLE users.

The low response rate and the nature of the survey makes it not unlikely that the results of the survey of colleges and universities exhibited respondent bias toward the better practices in the sector rather than being typical. This possible lack of representativeness with the results probably illustrating the better practice end of the spectrum does not mean that the results are not useful, but needs to be taken into account in their interpretation of them.

All the respondents used a VLE, mainly Moodle and Blackboard, with colleges having a strong preference for Moodle and universities for Blackboard and two universities using other VLEs. Both colleges and universities were mainly influenced by functionality, ease of use and availability of support in their choices, with universities also concerned about pedagogical issues and colleges about costs and the system being Open Source. The interest of colleges, but not universities in Open Source seems counter-intuitive, but it is possible that universities in general obtained VLEs earlier than colleges, when the main Open Source VLE, Moodle, was not yet available, although this was only indicated by one university. The institutions of the individual respondents used several other VLEs as well as Moodle. Since this was an international sample, it may indicate that the popularity of Blackboard and Moodle in the UK is not worldwide, though the sample is too small to confirm this. Two universities and one college mentioned accessibility or associated issues as being major factors in their choices and just under two thirds of the universities and colleges had taken accessibility into account in their choices. None of the universities or colleges used ATutor, which is considered to one of the most accessible VLEs [4].

The version of the VLE used is often important as a greater range of accessibility features are available with later versions. Unfortunately, even when there are not upfront financial costs associated with upgrading, there may be significant costs in terms of staff time. In addition, some learning will be required for new features or features which are implemented differently.

Nearly 40% of the colleges and two thirds of the universities thought that the VLE they used had accessibility features, with the majority of the reminder being unsure and one university thinking their VLE did not. The accessibility features respondents believed to be available included system customisation, compatibility with screenreaders and compatibility with different legislative accessibility requirements, although one respondent thought that no VLE was fully compliant with the UK Disability Discrimination Act. Comparison of respondents' knowledge or perceptions of available accessibility features with information from the manufacturers would be a useful topic for further research.

Three quarters of the colleges provide recommendations, guidelines and training on document accessibility and nearly 85% of the universities provide guidelines and recommendations and 72% training. Slightly smaller percentages provide guidelines and recommendations and training on the accessibility of PDF documents. In general the universities provided more detailed information about their recommendations, guidelines and training than the colleges. Universities used both the approaches of integration of accessibility issues into other courses and separate courses on accessibility. Other than the case of one university, which stated that the integration approach was the result of a policy decision, it is difficult to know whether the choice to use a particular approach was the result of a policy decision or other factors. While several colleges provided information about training, including on issues relating to the DDA, they provided no specific information on training on document or VLE accessibility.

Despite the results presented here probably representing the better practices within the sector, respondents from some of these institutions were uncertain about their practices with regards to accessibility. There is also the issue of the take-up of training and the way teaching using VLEs is implemented by teachers, lecturers and tutors. The comments about accessibility guidelines not being prominent or well known and teachers displaying inaccessible materials (on accessible web sites) are very telling. A number of institutions probably need to put considerable additional effort into publicising their guidelines and recommendations, improving take-up of training and encouraging members of staff to use this knowledge in their teaching. However, the extent to which these comments are typical of the actual situation would require further investigation, as would the relationship between good practice at different levels in an institution. This includes both how lecturers concerned about accessibility can have an impact on their institutions and how good practice at the institutional level filters down to individual lecturers.

Accessibility of VLEs to disabled staff and students has two main aspects:

- The design of the VLE and the accessibility features available.
- The way in which the VLE is used by individual teachers and lecturers, including whether or not documents and other materials made available through the VLE are in an accessible format.

Taking account of the first factor will require improvements in the design of VLEs, particularly with regards to their accessibility features, whereas the second will require a change of culture so that accessibility becomes an integral part of standard (good) practice in higher and further education rather than an add-on or optional extra. This cultural change will, of course, still need to be supplemented by widely available information and training.

Acknowledgements: Prof Mike Johnson of the University of Strathclyde for helpful comments and suggestions

6. References

[1] B. Bapturev, “Evaluation and Adaptation of Open Source Software for Distance Learning in Asia, 19th AAOU Conf, 2005.

[2] S. Carliner, “Course Management Systems Versus Learning Management Systems”, http//:www. learning circuits.org.2005/nov2005/carliner.htm.

[3] Catalyst IT Ltd., “Technical Evaluation of Selected Learning Management Systems”, Open Polytechnic of New Zealand.

[4] S. Clark and J. Baggaley, “Assistive Software for Disabled Learners”, *Int. Res. in Open & Distance Learn.*, vol. 5(3), 2004.

[5] S. Federici et al., “Checking an Integrated Model of Web Accessibility and Usability Evaluation for Disabled People", *Disability and Rehabilitation*, vol. 27(13), pp. 781-790. 2005

[6] M.A. Hersh and B. Leporini, “Making Conference CDs Accessible: a Practical Example”, ICCHP, 2008.

[7] M. Hotrum, B. Ludwig and J. Baggaley, “Open Source Software Fully Featured”, 2004, http://cde.athabascau.ca/.

[8] “Ergonomic Requirements for Office Work with Visual Display Terminals (VDTs)” Part 11, 1998, ISO.

[9] S. Leslie, “Open Source Course Management Systems”, EdTechPostBlog, 2004, http://www.edtechpost.ca/pmwiki.php/Ed/TechPost/OpenSourceCourseManagement/Systems.

[10] http://www.w3.org/TR/WAI-WEBCONTENT/.

[11] http:www/w3.org/TR/UNDERSTANDING-WCAG20/.

Multisensory Games for Dyslexic Children

James Ohene-Djan and Rahima Begum
Goldsmiths College, University of London
New Cross, London SE14 6NW
j.djan@gold.ac.uk

Abstract

A significant problem faced by dyslexic children is a lack of learning technologies designed to help children learn in settings when there is no personal teaching assistance. This paper presents an online learning technology that utilises Multisensory teaching, and interactive gaming techniques to provide dyslexic children with an engaging learning environment within which to identify where their mistakes in reading, writing and arithmetic lie. It is hoped that by providing this example of a interactive learning system specifically created for the needs of dyslexic children will raise awareness and understanding among learning technology software developers and practitioners.

1. Introduction

Dyslexia is a neurological problem that covers a wide range of reading disabilities [1]. Although still not fully understood it is recognised that what most dyslexics have in common is a difficulty in grasping the shapes of letters and then relating those shapes to the sounds that the letters symbolize. Dyslexics often reverse the order of the letters in a word or even leave them out completely. Other effects of Dyslexia include difficulties in memory, organisation, numeracy [2], time management, low self-esteem and a lack of self-confidence [3].

In the UK it is estimated that one in ten children exhibit some form of dyslexia and it is estimated that 80% of people diagnosed with learning difficulties are also dyslexic [4]. A proven approach to helping children overcome their dyslexia is to enable them to practice weaknesses and to identify where their mistakes in reading, writing and arithmetic lie. Using such an approach it has been shown that dyslexic children can learn subject matter just as well as non-dyslexic children. However, to achieve this often the child must be taught using alternative teaching strategies and be supported by a personal assistant to help identify mistakes and monitor progress.

A significant problem faced by dyslexic children is a lack of learning technologies designed to help identify weaknesses in the absence of personal assistance in settings such as in home. The vast majority of the software available is designed to be used in school settings with teachers controlling the pace and form of learning. Furthermore, as many schools find it difficult to fund support teachers to provide personal assistance this software is sometimes not used or available in school settings.

Support for dyslexic children to study at home generally takes the form of practice worksheets containing a range of study exercises realized as multiple choice questions, training exercises and to open questions. However, such worksheets are often criticised for there lack of interactivity and failure to engage the child so as to motivate them to learn.

This paper presents The Dyslexia Activity System (DAS), an online learning technology that utilises Multisensory teaching [5] to provide dyslexic children with an engaging learning environment within which to identify where their mistakes in reading, writing and arithmetic lie. Although designed for young dyslexic children in key stage one of the UK's education system, DAS can also be used for non-dyslexic children to improve on sum numeracy, word building, memory and sequencing skills.

2. Background

Multisensory teaching can be understood to be a method of teaching in which strengths that dyslexic children appear to have over non-dyslexic children, such as extra creativity and stronger sensory receptors (tactile/touch), are implemented as part of the teaching process. Originally proposed by a collective of learning difficulty specialists, teachers and researchers in the late 1920s [6], and significantly developed in the 1970's by Gillingham & Stillman [7], its aim is to find out what triggers productive learning in children with learning difficulties and how to develop teaching strategies that supported their learning. Recent Studies from the National Institutes of Child Health and Human Development have shown that multisensory teaching is the most effective teaching method for children with learning difficulties and is a crucial development tool for children with dyslexia [8].

Multisensory teaching consists of a string of Multisensory strategies that include techniques for linking eyes, ears, voice, and hand movements to symbolic learning. The approach taken is to try and engage as many sensory receptors in the learning process as possible, since it is argued that on many occasions, children with learning difficulties appear to have extra receptive sensors that can be used to bookmark learning events within their the memory.

An example of a Multisensory teaching approach is to use graphics and strong colours to make associations between shape, letters, words and numbers that relate to the same topic. Multisensory teaching also uses tactile objects and touching for emphasize during study. For example often dyslexic children find it difficult to distinguish the letters “b” from “d”. So the child is asked to draw a giant letter “b” on the carpet with his finger feeling the texture, since the child's sensory receptors are perceived as strong it is hoped their memory system will recall the “feeling and shape of the letter” and thus make identifying it easier in the future.

Multisensory teaching approaches can also be applied in two dimensions though the use of pictorial representations that enable children to form associations with letters, words and numbers. For example, the letter “A” can be represented as a string of apples connected together to make the letter. Multisensory teaching is very open and flexible approach that aims to work in different ways for different individuals, which is precisely what children with dyslexia require.

Often children with dyslexia also have difficulties with in various areas of mathematics, for example multiplication, fractions, decimals, percentages, ratio and statistics [2]. Using Multisensory teaching approaches to the design of mathematical exercises has proven to successful in improving individual abilities by reinforcing the relationship of numbers to actual quantities. [9].

Broadly, educational learning games introduce strategies and elements of games into a learning system's structure and modes of interaction.

Educational learning games usually comprise of all the elements that traditional games require such as rules, challenges interactivity and creativity. When designing educational learning games for children it is important to use graphics, symbols, animation and relatively low amounts of text on the user interface. Such considerations help to engage the child to interact with the games, make them more fun and interesting which all contributes to the environment of learning. [10]

Educational learning games have proved an effective way of motivating children with learning disabilities to learn. Children tend not to see learning as a chore and are often more willing to have an attempt at a game then a worksheet. In the case of Dyslexic children activities involving gaming strategies can be used as a reinforcement factor that allows children to see mistakes in reading, writing and arithmetic as challenges to completing the game. ICT and games can be used to present an active learning environment, which is crucial for children with learning difficulties such as dyslexia. [11].

3. Dyslexia Activity System

The Dyslexia Activity System (DAS) reported in this paper is an online Multisensory teaching system requiring high levels of child interactivity and engagement. The system is designed to support learning though a series of gaming techniques and association reinforcement exercises. These activities have been designed to help capture a child's attention and motivate them to learn through a fun environment. An aim of the system is to motivate children to build and strengthen their keys skills such as numeracy and literacy though interactive play. Although the primarily designed for dyslexic children, it is hoped that the use of Multisensory teaching approach embodied within DAS will also benefit non- dyslexic children and those with other learning needs.

3.1. Overview of design of DAS

DAS presents an alternative approach to traditional paper worksheets by presenting a set of Multisensory teaching exercises as interactive games tailored to the child's needs. Each game has been designed using minimal user textual input and provides the child with control over the learning process. By giving the child control of the application it is hope to develop self-confidence and drive to succeed.

Paper worksheets make it difficult for the child to see their progress, which can in effect motivational levels. IN DAS an animated interactive score bar details a child progress based on numbers mistakes in reading, writing and arithmetic. The system has been designed in such a way as to allow the dyslexic child to attempt an exercise or choice within an exercise multiple times so that they may correct mistakes. Correct scores are reinforced with motivational prompts and these are used show the child the benefits of their hard work. Although DAS has been specifically designed for young dyslexic children in key stage one of the UK's education system, it can also be used for young children regardless of whether children have dyslexia because children can improve on sum numeracy, word building, memory and sequencing skills.

A criticism of some ICT systems used by dyslexic children is that their interfaces are too complicated and have too much text that confuses users and generates cognitive overload. DAS has been created using a simple clear, bold interface, supporting the customisation of colour schemes to minimise the effects of dyslexic. These colour schemes play a crucial role for creating a system for dyslexic individuals, since strong colours and complicated patterns can be distracting. DAS uses light pastel colours, which helps lift the text of the page and becomes easier to read for dyslexic children.

3.2. Multisensory teaching in DAS

Within DAS Multisensory teaching of exercises has been implemented as a set of activities. Activity one is a letter recognition exercise, which helps develop reading, organizational and memory skills. Activity two helps children develop number recognition skills. Activity three is a number sequencing exercise designed to help develop memory skills and numeracy. Activity four is a vowels and phonics exercise, which helps the child in developing language skills and Activity five is a sequencing and character recognition exercise is designed to coach colour and shape recognition.

Grouping Strategy is a words recognition and organization activity. The purpose of the activity is to help the user understand what the words means and what category it belongs in. By sorting through the words it also helps the child build on their organizational skills.

Fun Sums is a numeric and mathematic based activity aimed at helping children to understand how to solve sums and simple subtractions and multiplications.

3.3. Examples of multisensory exercises

Figure 1 shows an example Activity one level letter recognition exercise. The exercise uses symbolic clues, colours and the mapping of associations to reinforce the learning experience. This exercise is used to help a child develop a range of reading skills.

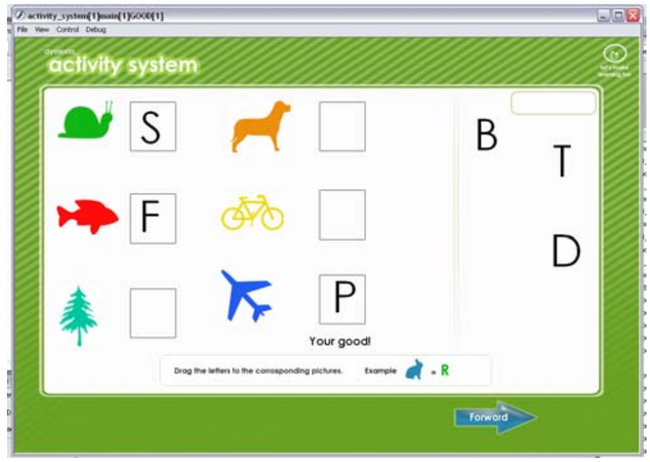


Figure 1. Letter recognition exercise

Figure 2 shows an example number recognition exercise. The exercise is designed to reinforce the shapes associated with numbers and number sequences.

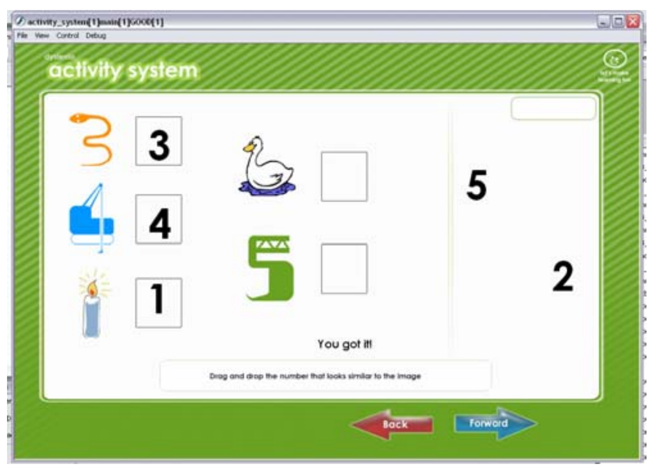


Figure 2. Number recognition exercise

Figure 3 shows an activity exercise called the "Vowels in a Basket". This exercise is vowels and phonics exercise designed to help children in developing language and organizational skills. This is accomplished via the use of multisensory teaching and the use of pictures as clues to help the child. The activity uses strong colourful images to make the working environment lively and fun.

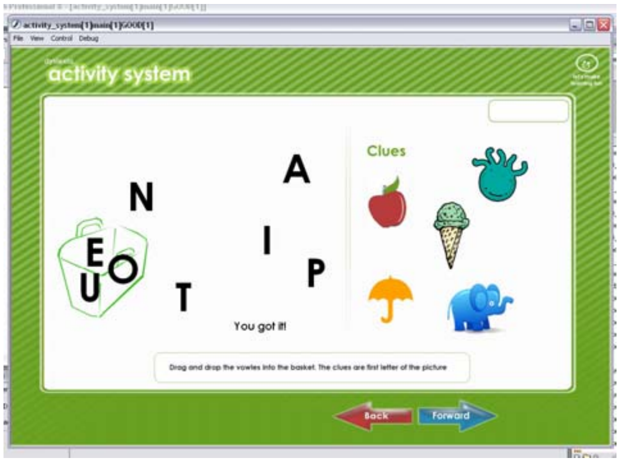


Figure 3. Vowels in a basket

Figure 4 shows an exercise designed to support multisensory teaching of sequences and shape recognition. The exercise uses a clear layout with simple instructions together with colour and shape recognition supported by a "drag and drop" interface.

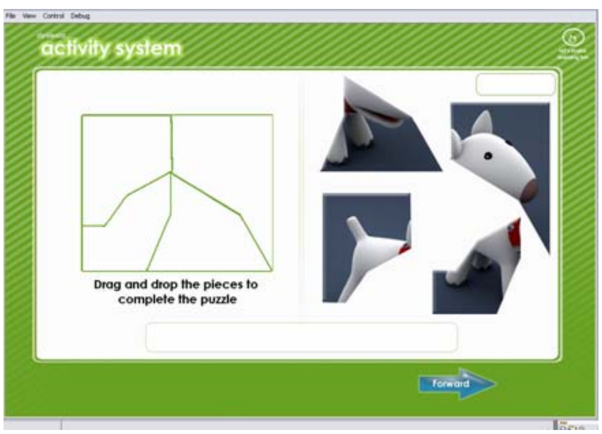


Figure 4. Shape and recognition exercise

Figure 5 depicts a grouping strategy exercise designed to teach word recognition skills. The purpose of the activity is to help the child understand what the words mean and what category they belongs to. By sorting through the words it is hope that children will also improve their organizational skills.

To make the activity easy to understand, each exercise of this type is supported by a brief description. To make it easier for children to distinguish the family groupings of words each group is designated its own colour. The child is required to drag and drop all the corresponding words into the correct family. Attempts, mistakes and results are shown in a score bar.

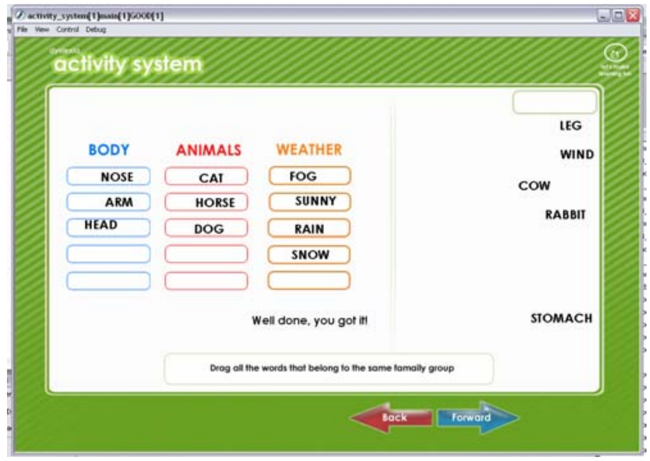


Figure 5. Group strategy exercise

Figure 6 shows "Fun Sums", a numeric and mathematic based activity designed to teach the fundamentals of adding, subtraction and multiplication. The current question is highlighted while the rest of the questions are faded. To assist the child in resolving the questions, animations are used. For example the question uses an animation of oranges falling into a basket to ask what is 4+4. Four oranges are in the basket and the animation shows the other four falling into it. This helps in breaking the question down for the child and makes them aware of how to solve the question. In essence the animation is a support teacher.

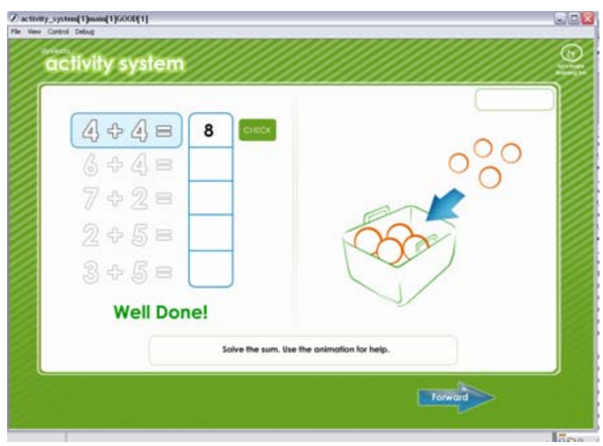


Figure 6. Fun Sum exercise

4. Related Work

Worksheets are the most common form educational learning materials used to teach dyslexic children. Worksheets are used to "drill and test" children and provide them with skill building practice. Since they are fairly low cost to produce, worksheets play a major role in the schools and are used by teachers to guide learning. Worksheets usually contain learning material on letters, numbers, and shape identification and are very easy to obtain from the Internet or local educational authorities.

A significant drawback of worksheets is that they are often viewed as a chore or even punishment that does not engage or stimulate the children. Studies in children's behaviour and learning have shown constantly that children learn better through active involvement with real tactile objects and with a combination of multisensory teaching techniques. A further drawback is that children with learning difficulties, especially dyslexic children often struggle digesting material on worksheets due to being compacted with text and with complicated formats [12].

Wordsworks is a commercially available multisensory teaching tool designed for adults (www.wordswork.co.uk) that embodies design principles similar to those reported in this paper. Wordswork is an interactive support system that contains a range of activities and tools. Some of the topics that Wordswork addresses include: improving reading, spelling, punctuation, essay writing, mind mapping, punctuation, handwriting and oral presentations. The system is designed to encourage the adults to practise strategies and suggest approaches to make their learning more manageable [13].

Even though the existence of Wordsworks demonstrates the potential of using ICT to teach using a multiseronry approach it does not lend itself well to the teaching needs of children. In particular, it has been suggested that its user interface and content are inappropriate for teaching under 10s and that the levels and type of interactively is not appropriate for children. Through the development of DAS it is hoped that it can contribute towards the development of a commercial multiseronry teaching tool designed specifically for children.

5. Conclusions

We have presented an online learning technology called DAS that utilises Multisensory teaching, and interactive gaming techniques to provide dyslexic children with an engaging learning environment. We hope by demonstrating interactive learning system specifically designed for the needs of dyslexic children we will raise awareness and understanding among learning technology practitioners.

10. References

[1] L. Peer and G. Reid *Introduction to dyslexia*: What is dyslexia, chapter 2 pages 13-14. Part of the British Dyslexia association. ISBN 1853469645 (2003).

[2] J. Herold. *Dyslexia and math's*. On-line article. Web link: www.dyslexia-parent.com/mag43.html (Feb 2003).

[3] M.J. Snowling, *Dyslexia is Not a Myth*. On-line article web link: www.bdadyslexia.org.uk/news17.html University of York. (2005).

[4] B. Hornsby, *Overcoming Dyslexia*: A Straightforward Guide for Families and Teachers ISBN-10: 0091813204 Vermilion; 3Rev Ed edition (1996).

[5] C. Singleton, *Understanding dyslexia*. Web link: www.portobello.edin.sch.uk/LSSN/LSSN2.html. University of Hull. (2000).

[6] H. Schupack and B. Wilson, *The "R" Book, Reading, Writing & Spelling*: The Multisensory Structured Language Approach, Baltimore. The International Dyslexia Association's Orton Emeritus Series. (1997).

[7] J.R.. Birsh. *Multisensory Teaching of Basic Language Skills*, Second Edition, chapter 1, page 27. ISBN 1-55766-676-8. (2005).

[8] J. Bradford *What causes dyslexia*. Web link: www.dyslexia-parent.com/mag24.html, (2003).

[9] L. Trie, Stanford Report Remediation training improves reading ability of dyslexic children. On-line article. (2003).

[10] W. Goldup. *Dyslexia Review*: The journal of the dyslexia institute Guild, volume 15, Number 2 pages 14, 19. ISSN 0308 6275. (2004).

[11] C. Singleton and J. Hutchins. Computer and literacy skills: Reading Software, chapter 5 pages 45. ISBN 187 2653 02 2. (1991).

[12] P. Patten, School of Human Resources and Family Studies, University of Illinois Worksheets: Good or Bad?. Web link: www.nncc.org/Curriculum/dc26_worksheet.html, (1996).

[13] E. Morgan Wordswork, Web link: www.dyslexia-adults.com/wordswork.htm, (2000).

Accessible interfaces for educational multimedia contents

Lourdes Moreno, Ana Iglesias, Paloma Martinez, Belen Ruiz
Computer Science Department, Universidad Carlos III de Madrid, Spain
{lmoreno, aiglesia, pmf, bruiz}@inf.uc3m.es

Abstract

The use of technology is growing in every field of education, and not only in the education of disabled students but also as a learning resource for everybody. The teachers are more and more introducing these digital contents in their lessons and there are many resources related to learning on internet.. If an equal access to these resources is guaranteed, then we can avoid students feeling that their learning capacity is limited due to a possible inaccessibility to them. Inclusive methodologies have to be followed to reach these objectives applying the standards such as Web Content Accessibility Guideline (WCAG) and rules of accessibility in the design and development of web pages, technical supporting, software, author tools, etc. This papers describes a practical case with two accessible interfaces of multimedia resources implemented with Synchronized Multimedia Integration Language (SMIL.).

1. Introduction

The electronic books, educational software, audiovisual resources, web pages are now used as assistant tools, complementary resources and sometimes even as the only resource available to provide certain contents within the educational system. If an equal access to these resources is guaranteed, following the Universal Design Principles [4], then we can avoid students feeling that their learning capacity is limited due to possible accessibility barriers.

Inclusive methodologies are required following the standards and rules of accessibility in the design and development of web pages, technical support, software, author tools, etc. The need is obvious, we found ourselves with the need of these technologies in non inclusive educational systems as well as in the inclusive ones. The students have the right to be given the access to these systems independently from its form of access of use. There are alternative technologies to obtain accessible products such as multimedia contents and web pages. The author software tools do not only create accessible products but permit adapt resources giving them a better accessibility, including captions and/or audio description to an audiovisual content for students with an audio or visual disability, providing an audio description to graphs and equations for students with visual disabilities, etc.

Next section shows related work and technological aspects and standards are given in section 3. A case study is described in section 4 and finally some conclusions are given.

2. Related work

To provide access to digital resources in accessible applications and web sites there are three standards to be considered: the guidelines for developing accessible learning applications of Global Learning Consortium (IMS) [8], the World Wide Web Consortium (WC3) [17] and the Web Accessibility Initiative (WAI) [19] which play a leading role in promoting the importance of accessibility and developing guidelines which can help when developing accessible Web resources.

The WAI develops guidelines of accessibility for different components; multimedia and audiovisual contents are specially treated in WCAG. It demands alternative contents (caption, audio description, extended audio descriptions and sign language interpretation) to achieve different levels of accessibility.

To elaborate and edit accessible digital resources some normative must be followed, as the study in the educational area of Accessible Digital Media of NCAM [15], which offers a complete and valuable guide of recommendations, tools and development techniques to create all types of accessible multimedia resources.

Focusing on research in the area of education and strictly related to the accessibility, we find ourselves with the use of metadata with various uses, but the most important one is the initiative of "Access for all", AccessForAll Meta-data [8] of IMS. Further on we will refer to this initiative of huge interest in any e-learning platform that really does want to provide accessibility. Basically, it is an attempt to repair the imbalances between the system resources and the user needs ensuring a definite access for all the users and giving different views according to the preferences and characteristics of the users in the learning process.

3. Accessing multimedia contents in web

There are useful technlogies for developing and using accessible contents. For instance, user agents (as browsers) give access to the Web information, software for developing and editing accessible contents or authoring tools for making easier the production of accessible resources or adapting non-accessible contents (for example, adding audio description to a video).

Assistive technologies are also very useful for accessing web resources. When a user wants to access an Internet resource, s/he can access it using an Indirect Access. This technology enables to use computers in a non-direct way, been useful, and sometimes necessary, for users with disabilities.

Nowadays, there are available a great number of tools to develop and support of multimedia on the web. In this way, authoring tools help us to create audiovisual contents integrating caption and/or audio description, and help us to edit them so that prerecorded multimedia can be included. Some examples of technologies to make accessible multimedia contents are:

- Languages and formats to synchronize multimedia, highlighting QuickTime [2], SMIL [20], Microsoft® Synchronized Accessible Media Interchange (SAMI) [10]
- Players, such as RealPlayer [16], QuickTime [2], Windows Media [11], etc. or SMIL players as Grins player, Ambulant [5]
- Caption and/or audio description editors for multimedia, such as Media Access Generator (MAGpie) [14], Hi-Caption Studio [6] or utilities as CaptionMeNow [7]
- Editors to convert multimedia presentation to an accessible format such as Flash Macromedia [1] used by many designers, SMIL editor as LimSee2 [9].
- Others, such application as SVG for images. The combination of using SVG and SMIL permits to create multimedia contents.

There are so many different formats, platforms, players, languages and technologies that the task of making multimedia accessible is sometimes really difficult, but it is not impossible. It is indispensable to follow the standard guides and recommendations of the W3C. For instance, the browsers and multimedia players must fulfill the User Agent Accessibility Guidelines (UAAG).

WCAG 1.0	WCAG 2.0
Guideline	Guideline
1. Provide equivalent alternatives to auditory and visual content..	1.2. Provide synchronized alternatives for multimedia
Checkpoints	Success Criteria
1.3. Until user agents can automatically read aloud the text equivalent of a visual track, provide an auditory description of the important information of the visual track of a multimedia presentation. [Priority 1]	1.2.2. Audio descriptions of video, or a full multimedia text alternative including any interaction, are provided for prerecorded multimedia. (Level 1).
1.4. For any time-based multimedia presentation (e.g., a movie or animation), synchronize equivalent alternatives (e.g., captions or auditory descriptions of the visual track) with the presentation. [Priority 1]	1.2.1. Captions are provided for prerecorded multimedia. (Level 1).
	1.2.2. Audio descriptions of video, or a full multimedia text alternative including any interaction, are provided for prerecorded multimedia. (Level 1).
	1.2.3. Audio descriptions of video are provided for prerecorded multimedia. (Level 2).
	1.2.4. Captions are provided for live multimedia. (Level 2).
	1.2.6 Extended audio descriptions of video are provided for prerecorded multimedia. (Level 3).
not mapped-	1.2.5.- Sign language interpretation is provided for multimedia. (Level·3)
	1.2.7.- For prerecorded multimedia, a full multimedia text alternative including any interaction is provided. (Level 3)

Table 1.- WCAG 1.0 y 2.0. Accessibility criteria for audiovisual multimedia contents.

Multimedia contents are specially treated in WCAG 2.0 [21]. It demands alternative contents (caption, audio description, extended audio descriptions and sign language interpretation) to achieve different levels of accessibility as it is indicated in Table 1. This version is more specific and measurable than the version 1.0 [18]. It distinguishes between pre-recorded and live multimedia, audio description and extended audio description. The sign language is considered as a new alternative content and the script element is also added, as well as complete transcription of characters, action, context etc.

It is necessary to ensure two different requirements for accessibility: the multimedia content is accessible following the WCAG and the access to the multimedia resource must be accessible. In addition, we can not forgot the necessity of integrate the multimedia contents in an accessible and usable user interface (Web page, player, etc.). Then, the contrast of colours, accessible buttons for control (alternative texts), etc. in the interface must be taken into account. Furthermore, the user should be allowed to interact with every hypermedia element in the interface, controlling them in a device-independent way.

4. CASE STUDY

The resources were built for The Spanish Centre of Captioning and Audio description (CESyA) [3] devoted to promote accessibility in audiovisual media using captioning and audio description services. One of the main goals of this centre is to study how to integrate accessible multimedia resources in different media [12].

To achieve this, personalized educational resources could be offered to all the functional diversity in an inclusive way. The multi-modal interaction makes possible the access to students with disabilities to use multimedia educational resources, but also provides advantages independently of having or not disability in learning presenting the information in a visual way and audio-described [13].

In this line, a study case is presented. Two different accessible interfaces have been built. Both of them are able to play any multimedia content. The interface in Figure 1 allows the user to activate and/or deactivate the different audio and textual alternatives within the multimedia information.

Figure 1. Accesible Interface Prototype for Audiovisual Works Reproduction

On the other hand, the interface in Figure 2 has been built for using it at the University. This interface shows different learning resources presented in a real class. These learning resources are presented digitally, providing captioning, audiodescription and transcription. The final user is who decides what to watch in every moment, interacting with the interface controls for activate/deactivate each resource.

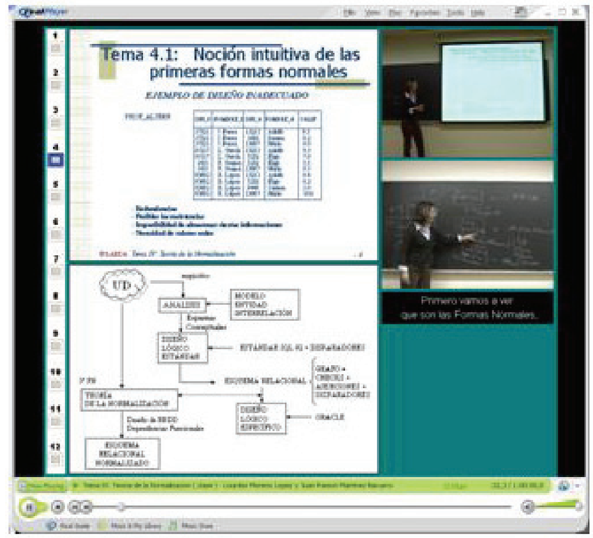


Figure 2. Accesible Interface Prototype for Learning Resources Reproduction

Both interface prototypes have been implemented using SMIL 2.0 and the reproduction of their multimedia content is associated to an external player: Real player [11]. SMIL technology started off as a technology to develop the multimedia contents on the Web. It is a market language which creates multimedia presentations containing audio, video, image and/or textual elements. These elements are separately stored and reproduced in a synchronized way. In the Web accessibility field, SMIL also allows the creation of audiovisual contents with captioning and synchronized audio description.

SMIL is compatible with the following players: QuickTime Player, RealPlayer, Grins player and Ambulant among others. It is important to underline in this point that different players of SMIL provide different levels of implementation, that is to say, not every accessibility characteristic described by SMIL is supported by the player. Although the interfaces have been developed by SMIL, not all the players implement it in the same way, and the results are slightly different. In these cases Real Player is used as it is a player which apart from its extended use, implements a high level of SMIL which has permitted:

- To add hypermedia elements to the interface such as buttons associated to events, to provide adaptability to the interface and allowing the user to control the

different means that are presented to him (including audio description, caption, both or none).
- To follow the philosophy of SMIL, as well as synchronizing audio description and caption. This makes the multimedia content accessible. Accessibility to the interface and its use by means of different access devices such as the mouse, keyboard and now voice synthesis is being researched.

To emphasize that the characteristic of adaptability is interactive, it does not have to decide which adaptation of contents the user wants at the beginning, but has to be able to personalize its interaction whilst the reproduction is taking place.

4.1. Developing with SMIL

The coding in SMIL is based on the creation on regions in which the different multimedia contents which will contain the presentation with the tag <root-layout> and <region> are included. Different multimedia contents have been associated to each one of these regions. Moreover, some regions have been created in order to include the interface controls for activate/deactivate each accessible resource. Once the regions have been defined, the multimedia resources have been included using the <body> tag. Moreover, depending on the type of mean which we are going to make reference to, a different tag is used: <audio>, <video>, <textstream>, etc.

In the inclusion of the different elements in the code it must be stressed that that better results are given when adding the lighter elements before the bigger ones due to problems of synchronization which may emerge. This does not appear in the specification of SMIL, not even something which could be extended to every example but it is a conclusion extracted from the different trials which have been carried out. It is important to point out that the different implemented controls have been included through images.

If we make reference to how the different buttons control the different means its function should be explained according to the mean in question. In general the only way to start up the means in SMIL is by means of begin and end events through the tags <begin> and <end>and according to the element which is being dealt with, we will define its function. For example, if we are working with the audio control we can see that it is being done through the attribute <set> as it is shown in Figure 3.

We use the attribute <set> to achieve the activation and deactivation of the audio-description. With the <target element> tag we make reference to the region that contains the audio-description archive. With the <attribute name> tag we indicate that sound level is the attribute to be modified. The difficulty is found in the interactivity, and finally the activation or deactivation is simulated by the means of the <to> tag and indicating the percentage of volume that we want to be maintained. In other words, in order to inactivate a means it is necessary to set the <to> tag to “0%”; to activate it, it is necessary to set <to>=100%.

```
<!—FILE AUDIO -->
<audio
region="audio"
src="audio/audioforall.rm">
<set
targetElement="audio"
attributeName="soundLevel"
to="0%"
begin="stop_audiodes.activateEvent"
dur="0.5s"
fill="freeze"/>
<set
targetElement="audio"
attributeName="soundLevel"
to="100%"
begin="play_audiodes.activateEvent"
dur="0.5s"
fill="freeze"/>
</audio>
```

Figure 3. SMIL code of implementation

Finally notice that the event is launched using the attribute <begin> relating it to the corresponding button according to the function that it is wished to have, to activate the means it is needed to set <begin>=“play_audiodes.activateEvent” and to deactivate it, it is needed to set <begin>=“stop_audiodes.activateEvent”. In the rest of the cases the means are activated and inactivated using begin and end events just as the ones used in the previous case but they are not included in the code using <set> but done directly in the declaration of the corresponding multimedia element. It is important to point out the way of making the means that include images disappear from the presentation (caption, transcription) is done using layers that are superimposed over the means when the user wants to inactivate it. We have created a method that allows us to apply, with the attribute <set> in conjunction with <z-index> the same effect of layers to avoid the scrolling bar being restarted when a new element is launched. Finally we also need to make reference to the inclusion of alternative descriptions for every element included in the presentation, buttons or means. This is implemented using the <alt> tag. In the label code <alt> we are allowed to add an alternative description which will later be shown by the player.

5. Conclusions

In this paper, a case study has been presented. Two accessible interface prototypes have been implemented using XML technologies as SMIL. These interfaces reproduce multimedia audiovisual works and multimedia educational contents in an accessible way. They have been developed according the Universal Design and they favours the inclusion. These prototypes offer personalization of the alternative contents such as caption, audiodescription or transcription in an interactive way.

6. References

[1] Adobe. Flash Macromedia, http://www.adobe.com/devnet/flash/articles/flash8_bestpractices_09.html , 2007.

[2] Apple. Quicktime, http://www.apple.com/quicktime/win.html , 2008.

[3] CESyA. The Spanish Centre of Captioning and Audio description (CESyA), http://www.cesya.es , 2005.

[4] Connell, B. R, Jones, M., Mace, R., Mueller, J., Mullick, A., Ostroff, E., Sanford, J., Steinfeld, E., Story, M., and Vanderheiden, G. "Principles of Universal Design." North Carolina State University, The Center for Universal Design, retrieved from http://www.design.ncsu.edu/cud/univ_design/princ_overview.htm, 1997 ,

[5] CWI. AMBULANT Open SMIL Player , http://www.cwi.nl/projects/Ambulant/ , 2007.

[6] Hi Software. Hi-Caption Studio, http://www.hisoftware.com/hmcc/ , 2007.

[7] IBM. CaptionMeNow , http://www-306.ibm.com/able/solution_offerings/captionmenow.html , 2005.

[8] IMS AccessForAll Meta-data Specification, http://www.imsglobal.org/accessibility/ , 2008.

[9] LimSee2. LimSee2, http://limsee2.gforge.inria.fr/ , 2008.

[10] Microsoft. Microsoft Synchronized Accessible Media Interchange (SAMI), http://msdn2.microsoft.com/en-us/library/ms971327.aspx , 2003.

[11] Microsoft. Windows Media Player, http://www.microsoft.com/windows/windowsmedia/player/11/default.aspx , 2008.

[12] Moreno L., Iglesias A., Martínez P., Accessibility of Multimedia Resources in Web, WEBIST 2007 (International Conference on Web Information Systems and Technologies), 2007.

[13]Moreno, L., Iglesias A., Castro E. and Martínez, P., Using accessible digital resources for teaching database design: Towards an inclusive distance learning proposal, The 13th Annual SIGCSE Conference on Innovation and Technology in Computer Science Education, ITiCSE ' 08. ACM Press, Madrid, 2008.

[14] NCAM. Media Access Generator (MAGpie) http://ncam.wgbh.org/webaccess/magpie/ , 2003.

[15] NCAM, Accessible Digital Media. Design Guidelines for Electronic Publications, Multimedia and the Web, http://ncam.wgbh.org/publications/adm/ , 2006.

[16] Realnetworks. RealMedia Player, http://www.realnetworks.com/ , 2006.

[17] W3C, W3C, The World Wide Web Consortium, http://www.w3.org/ , 1994.

[18] W3C, WCAG Web Content Accessibility Guidelines 1.0 , http://www.w3.org/TR/WCAG10/ , 1999.

[19] W3C, WAI, Iniciativa de Accesibilidad Web, http://www.w3.org/WAI/ , 2006.

[20] W3C, SMIL, The Synchronized Multimedia Integration Language, http://www.w3.org/AudioVideo/ , 2008.

[21] W3C, Web Content Accessibility Guidelines 2.0, http://www.w3.org/TR/WCAG20/ , 2008